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COMMUNICATION WITH LIGHT VESSELS.

THE report of the Committee which was appointed in February, 1887, to enquire into and report on the desirability of electrical communication between light vessels and lighthouses and the shore has been issued, as we announced in our last. With the constitution of the Committee considerable fault has been found, and, we think, with a certain amount of justice, as but two out of the nine were men possessed of pure technical knowledge, and these two were not men who have had experience of submarine cables. Others of the Committee were, we believe, known to have a bias against the general scheme; altogether, therefore, the unfavourable report which is now published might almost have been anticipated. The general substance of the opinion of the Committee is that as regards the *Sunk* lightship, the expenditure involved in maintaining electrical communication with the shore is not commensurate with the advantages gained, and that therefore it is recommended that the service be discontinued, and that electrical communication should not be established with outlying lighthouses or islands for the special service of saving life at sea. As regards the *Sunk* lightship possibly the opinion is justified; but it seems very unsatisfactory that a general condemnation should be based on a solitary experiment, made, probably, at a not entirely suitable place. The great bugbear appears to be the question of cost of maintenance, for the scheme does not appear to be entirely condemned, except on the score of expense. This might be heavy, but to base it on what the actual cost has been whilst the experiment was being conducted is hardly a satisfactory way of arriving at a conclusion. To estimate the cost of an Atlantic cable from the money expended on the first two or three cables laid, which eventually had to be abandoned, would not be considered sound logic. No doubt the cost would be great at first until experience had been gained, and possibly this would not be attained for some years; but in view of the general desirability of the venture, which is insisted upon from many quarters, a large grant by Parliament for the purpose would be amply justified, and would, we believe, be approved of by the public. It should be mentioned that the Danish Government is moving actively in the question, and has established communication, in many cases, with lighthouses and life-saving stations, and nothing is said about the expense of maintaining the cables which are used. That the matter will be allowed to drop we can hardly believe, and the whole question, not only as regards lightships, but as regard coast lighthouses and coast-guard stations must eventually be pressed to the front, and be thoroughly discussed by competent authorities.

THE PAYMENT OF EXPERT WITNESSES.

MR. LANE-FOX, speaking at the meeting of the Anglo-American Brush Company last week, said his services as witness in the recent litigation in which he was interested had been refused because he would not accept a retainer. These remarks will, no doubt, set many men thinking. The retaining of experts has become a common practice of late years. This, to a certain extent, is necessary, owing to the many technical points that now arise in the various causes brought forward for decision. But there has been a steadily growing system which has now reached the dimensions of a great evil. One of our leading Judges strongly commented upon this in a technical case brought before him recently. There cannot be the slightest doubt that good causes have been absolutely ruined by the dissembling of professional men, and another important result of this is that the statements many scientific men make will be met with a certain amount of discredit. At many of the sittings of the Board of Trade enquiry into the electric light provisional orders, the halting, hesitating manner in which some witnesses

gave evidence left no room for doubt that they were wavering between half truths and whole truths.

Such being the case, we are practically at the mercy of unscrupulous experts. Scientific men called in to assist a great work willingly and knowingly mislead those who are unacquainted with technical details, and this hideous injustice is done for a mere trifling sum of money. There is a great future for science, and day by day we draw nearer to the ultimatum of our hopes; why, then, should men who are capable of good work sacrifice their position as scientists and gentlemen when in so short a time every one will obtain his due? We have, indeed, come to a sad pass when men who might hold a high place in a great profession, stoop so low that they may be induced to enter the witness-box and make misleading statements.

REGARDING that latest American lunacy, *i.e.*, the Weems railway system, incorporated under the name of the Electro-automatic Transit Company, of Baltimore, with its speed of 180 miles an hour and its 143 patents, what can one say? Any engineer at any time can design an arrangement to prevent the loco. jumping the track, but it is the *tendency* to jump and the consequent friction and grinding that cannot be stopped and which in consequence wastes power. Of course by telescoping the carriages and making the front of the loco. pointed they get over a good deal of wind pressure, but we doubt if ever they run at 180 miles an hour, not even though they have demonstrated the success on a practical scale (*sic.*) in a *shed*. At any rate power proportional to about the square of the speed will be required, and for long distance traffic we know steam will never be surpassed in economy. One passage is significant. Says *Science*:—"This cigar-shaped car, painted a bright red and moving sharp end foremost, at first sight does not seem a wonderful thing as it goes quietly along the track; but later, when the engineer at the dynamo puts on more power, or, as a steam-car man would say, more steam, and the creeping thing on the ground hastens its movement until it fairly flies and becomes a moving speck of red, spectators feel the progress being made in applied science, and talk of the wonders of electricity, and the great things it will accomplish in the active affairs of life in the near future." We have no doubt they talk. We have little doubt that later they will invest their money in it. Later still they will lose it, and while they gnash their teeth with rage the inventor will most probably quietly retire to an estate purchased in sunny Virginia.

THE *Newcastle Daily Chronicle*, basing its opinion upon a statement in our contemporary *Iron*, whose knowledge of electrical matters appears to have reached its zenith in the time of John Banting Rogers, thinks that electricity is likely, after all, to prove a very questionable substitute for the gallows, because a Mr. H. M. Stevens, of Boston, received a shock which did not make him shuffle off this mortal coil. We read that "a circuit was completed with his body as a medium, and a force of electricity equal to 50,000 candle-power, shot instantly through him," and that from that day to this "he has carried the reminders of that terrible charge in his body." To the enquiries which are now being made in the States into the practicability of using electricity as a means of execution, we would suggest that experts should be examined with the view of ascertaining the exact candle-power necessary to cause death.

THE readers of our excellent contemporary, the *Electrician*, have much to be thankful for. Sir John Pender, one of its proprietors, and a gentleman whose philanthropic motives are unimpeachable, stated at the last meeting of the Eastern Telegraph Company, that the paper was not started with the object of making money but for the benefit of the staff of the cable companies in which Sir John is interested, and not so much to enlighten the public. This latter confession was surely unnecessary! Furthermore, we are informed on the same unquestionable authority, that all the earnings of the journal are returned to the men who write the scientific articles; if this is the case the profits may be readily gauged. But the "autocrat of the cable ring" is not consistent for many days at a time, for the modest disclaimer above mentioned is entirely upset by a remark attributed to him on the occasion of our contemporary's "wayz-goose." Said Sir John, as reported in the *Weekly News and Chronicle*, "They could not boast of the *Electrician* being a big property, but they were pleased to know it was a useful property, it being, indeed, *the real representative of electrical science in Great Britain*" It is indeed a useful property, for there is only one Sir John and the *Electrician* is his prophet (we had almost written profit); but until now we had no conception that electrical science in the United Kingdom was at such a low ebb.

IT has been suggested that the sparks which Mr. Crighton has witnessed from overhead wires in Old Broad Street may be due to the crossing of conductors belonging to the Exchange Telegraph Company. Indeed, one City electrician has told us that he does not believe there are any electric light wires traversing that classic neighbourhood. Can anybody inform us positively? The Exchange Telegraph Company's mains are worked at a difference of potential of 150 volts and carry a heavy current, so that it is quite pcssible that the coruscations which have so alarmed Mr. Crighton were caused by these. Accumulators are mainly used to supply the current to 600 or 700 printing telegraph instruments, and about 17½ electrical horse-power is daily absorbed in carrying on the service.

A WELL known electrician in a letter to us says: "I quite sympathise with him (Lane-Fox) *re* the Edison-Swan matter, and I wish some of the company mongers could be experimented upon with 2,000,000,000 volts." Mr. Stevens, of Boston, would probably think "50,000 candle-power" quite enough at one time.

IN our next issue we hope to publish the regulations of the Imperial Physico-technical Office, of Berlin, for testing apparatus for electrical measurements. It is possible that the promoters of the proposed standardis-

ing laboratory in London may find in these some hints worthy of attention.

THE paper of Mr. Leo Daft, which formed the theme of our leading article on the 19th ult., is, in our opinion, of such value that we shall reproduce it in full, and we therefore publish a portion of the article on another page. Now that several important electric traction schemes are being seriously considered in this country Mr. Daft's experiences may be found very useful.

WE have not seen until recently Mr. Edison's name prominently brought forward in connection with inventions for warlike purposes since the account of a trial of his electric gun, published in a New Orleans paper on the first of April, 1882. This gun, it may be remembered, to outward appearance was a long tube of glass with sundry handles and gearing attached to its breech end, but giving little external indication of the deadly nature of its discharge. For fear of doing damage inadvertently to life or property, the range of the gun was restricted to 2½ miles. A number of used-up mules and horses from the City of New York were turned out to graze, the animals being restricted from wandering by a barbed-wire fence. All being ready, the gun was discharged, when an immense volume of flame issued from the glass tube, rushing up the range towards the doomed animals. The ground over which the flame had passed, excepting that the grass was somewhat scorched, presented no visible signs of devastation, and the animals were still grazing. It was not until the spectators proceeded up the range that the murderous and destructive character of the fire was made manifest. It was found that every tree, shrub, or animal in a track about 100 yards wide was utterly consumed, and, although retaining its natural shape, collapsed into dust at the slightest touch, while the barbed wire fencing had entirely dissipated and vanished. As nothing more has been heard of the invention, we conclude that Mr. Edison considered its capabilities too fiendish to be introduced into warfare, and has therefore never divulged the secret. Torpedoes, however, are used by all nations, and are accepted as a legitimate form of weapon. In conjunction with Mr. Sims, Mr. Edison has brought out an electric torpedo, consisting of a submerged portion attached to a float having the form of a boat. The submerged portion is a spindle-shaped copper shell containing the propelling machinery, a cable by which the current is conveyed to the electric motor and steering apparatus, and a charge of dynamite or other explosive. This spindle-shaped shell is connected to the float at the bow by a triangular steel frame, and at the stern by a post. The float is of copper, made air-tight and filled with buoyant material, so that it may not sink if perforated. The triangular part at the bow is intended to clear away obstructions in the path of the torpedo, and acts either by lifting up light ones bodily or enabling the torpedo to slide under those of a more massive kind. The torpedo proper is divided into four compartments, the most forward contains the dynamite, from 250 to 500 lbs., the second is empty, the third contains the electric cable for conveying the currents, and the fourth compartment has a motor of 40 H.P., as well as the steering apparatus and shaft to the propeller. The cable, of which some 6,000 to 11,000 feet are carried, is paid out as required, and by this means saves the wear and tear of dragging it over the bottom. It is said this torpedo can travel at the rate of 20 miles an hour, that it is under perfect control, and that the machine can be kept in action for any time until a favourable opportunity occurs to explode the dynamite charge. Many other advantages are claimed for this pattern of torpedo.

MR. F. L. POPE, to whose evidence on execution by electricity we referred in our last issue, was caught napping by District Attorney Quinby. When asked if death by electricity would be painful or not, the Westinghouse representative said :—"I believe it is very painful." He then, in answer to a question as to whether the velocity of electricity was not greater than that of nerve sensation in the human body, replied that he thought it was. In that case, said Mr. Quinby, would not death by electricity be painless? Whereupon Mr. Pope said he supposed it would. His remarks upon the measurement of the resistance of living organisms also shows that his knowledge of the whole question at issue might be more profound.

OUR contemporary, *Invention*, is in error, but that is nothing new. We do not seize every opportunity to run down the phonograph, which, as a marvellous instrument, we fully appreciate, but we should decidedly object to a wonderful scientific discovery being made the medium for extracting money from the pockets of gullible investors, on the strength of claims which cannot now and never will be substantiated in this country. The story of the abandonment of the electro-motor for the treadle was given us as a fact by the attendant at the Gainsborough Gallery, where the phonograph has recently been exhibited, and the particular apparatus which had just then arrived from America, minus the electro-motor, was shown to us as the improved form, the previous arrangement for turning being open to many objections. Even assuming that the King-of-King's phonograph has an electro-motor attached why is an "enterprising electrician" required to dance attendance upon a simple arrangement like this which even the editor of our contemporary might, with a little coaching, easily manage to control without the fear of being bow-strung?

WE understand that Mr. Gisborne, of the Canadian Government Telegraph Service, is now *en route* to the Straits of Belle Isle, in the Government ss. *Napoleon III*, for the purpose of selecting cable landings, &c., in connection with the gulf telegraph extensions. He is accompanied by Mr. R. R. Dobell, of Quebec, the chief promoter of the Canada-Atlantic enterprise, and by Dr. Selwyn, the Director of the geological Survey of Canada. It is believed that the Canada-Atlantic cable will be an accomplished fact in the near future. A paper on transatlantic cable routes may be seen in our other pages.

"NOW, Mr. Gibbens, what is the greatest electrical resistance you have any experience of?"—"The resistance of the companies to putting their wires underground," replied the ready Commissioner, with an unmoved face and a merry twinkle of the eye.—Enquiry on Electrical Execution, N. Y.

THE ELECTRIC LIGHT IN BRIDGE CONSTRUCTION.

[BY A CORRESPONDENT.]

NEAR Tokay—what English connoisseur in wines is not familiar with the name of this little Hungarian town?—there is at present a great railway bridge in course of erection, and in order to illuminate the building ground there is employed a small transformer installation which presents some interesting features owing to the structural peculiarities required by the local conditions. In order to make the reader acquainted with these circumstances we will first give a brief description of the construction of the bridge.

The new iron bridge has to be erected below the present wooden one, but without in any manner interfering with the regular traffic on the line.

The fixing of the pillars is effected by means of caissons of sheet-iron of approximately the same form as the pillars, and which are put together on the spot.

To this end piles of about 20 metres in length were driven into the bed of the river; upon these was erected a platform, and upon this again was set the caisson.

In the cover of each caisson there are two round openings, large enough to allow two workmen to descend simultaneously. The tubular shafts which are placed above these openings contain two ladders for the ascent and descent of the persons employed. These shafts terminate in a so-called sluice for the purpose of raising up the material excavated in the bed of the river without interfering with the pressure of air in the caisson.

As soon as it is put together the caisson is suspended by very strong chains to a scaffold erected above it, the platform is removed, and the lowering begins.

When it has arrived at the water-level it is anchored to the shore with chains in order that when being let down it may not be swept from its place by the current.

At the same time the operations of the masons commence, and to preserve the recent masonry from damage screens of sheet-iron are affixed to prevent the access of the water.

Unfortunately the caisson, with a wall of 8–10 metres, stands upon very uneven ground, so that it takes a slanting position, and there is danger of damaging the entire masonry. There is a confused noise of orders given and of the running of many hundred workmen with tools. The tube is affixed to the sluices in order to pump in air and to drive out the water so that the workmen may as soon as possible enter the shaft and remove all unequalities.

As soon as the pillar stands upright the chains are removed. The workmen descend through the shaft into the caisson and draw out the bolts by which the chains are secured to the caisson. The bolts are simply inserted without being secured from without by a female screw; the head of the bolt is fitted with a ring of rubber and is held on so firmly by the pressure of air in the caisson so that there is no fear of its becoming detached.

There is great difficulty in drawing out such a bolt, and as soon as this is effected, the ears are saluted by a fearful roaring and whistling, occasioned by the escape of the air through the hole. For the moment respiration becomes difficult by the rarefaction of the air, and the caisson is filled with a dense mist, which obscures even the electric light within. This lasts for three or four minutes, during which a workman who stands ready secures the aperture with a wooden plug. In this manner about 12 bolts are removed, and after all the temporary fittings required have been taken away, the excavations in the bed of the river begin to secure a good foundation for the pillar.

As the operations have to be completed with great rapidity, the work goes on day and night with the aid of the electric light, and as the works are very extensive, an installation of transformers has been arranged, the leads (primary and secondary inclusive), consist of about 5,000 metres of copper wire. The light is given out from 6 arc lamps and 80 glow lamps. The former serve for lighting up the ground outside and the bridge, whilst the glow lamps are distributed in the caissons, the dwelling houses, the stores, and the watchman's box. The transformers are placed in wooden cages, supported upon special wooden pillars, from whence the leads branch out in order to supply the arc and glow lamps of the various secondary distribution stations. The arc lamps give a splendid effect, and light up the ground so well that the stonemasons can continue their work in the night without difficulty.

The leads in the caissons are conveyed in a peculiar manner, to suit the circumstances of the locality. Close to the sluices there are passed down two gas pipes, which open into the caissons below, and are there well closed. Within these pipes the leads taking the current to and from the glow lamps in the caissons are conveyed. The pipes are filled with tar, grounded above with a stuffing-box, through which the wire is passed. Close to the scaffold there are two reels of wire, so arranged that on lowering the caisson the necessary length of wire is unwound automatically.

To produce the electric current there is a self-exciting alternating current machine, capable of yielding 15,000 watts, driven by a locomotive. As various work machines are driven by the same engine, the strain is very variable, wherefore a compensator is employed, which compensates the fluctuations of the current so completely, that all the arc and glow lamps give a surprisingly steady light.

As the work inside the caissons has to be carried on, even in the daytime, by artificial light, the electric installation is in continuous action.

ON THE ELECTROLYSIS OF DISTILLED WATER.

Note by M. E. DULER.*

IN these researches I employed distilled water contained in glass tubes with two branches, which, at the end of several months, imparted no alkaline character to the water. The electromotive force that I employed was very considerable, and always about 100 volts.

I took as electrodes: (1) an anode and cathode of platinum; (2) anodes of very different metals, principally nickel, cobalt, iron, copper (in this second case the cathode was of platinum); (3) the anode being of platinum, the cathode was of tin, bismuth, copper, lead, mercury, aluminium, &c.

In the first case, if the cathode is formed of fine wire, whilst the anode is a large plate, the electrolysis of the water gives off only hydrogen for several days; at the end of this time, the oxygen begins to appear at the positive pole, but its volume is always less than half the volume of the hydrogen liberated; the water subjected to this electrolysis acquires a somewhat acid reaction.

In the second case, the anodes are attacked, and, during the first few hours, give off protoxides; a substance is formed at the positive pole which is green with nickel, pink with cobalt, and blue with copper . . .; then, at the end of several hours, the protoxides change, take a more or less dark colour, and change into peroxides. Leaving the electrolysis to continue for several months, I found that, generally speaking, the oxide surrounding the positive pole ends by being partially reduced; thus, the peroxide of nickel passes back into the form of protoxide, becoming green; that of cobalt, which was maroon, becomes pink; and that of iron loses its reddish colour, and turns almost white. This transformation requires about two months for nickel and cobalt; for peroxide of iron it only commences at the end of seven or eight months. It seems to me that these deoxidisations might be compared to those produced on certain peroxides by oxygenated water.

* *Comptes Rendus*

Lastly, in the third case, that in which the negative electrode consists of a different metal to platinum, I found that, contrary to my expectation, this metal generally became oxidised. Tin gives oxide of tin upon becoming disengaged from the hydrogen; bismuth gives similar results.

A negative electrode of copper becomes covered with a deposit that almost stops the passage of the current, even when the electromotive force is 120 volts. Lead at the negative pole becomes covered with grey tufts, which, when the current is interrupted, give rise to a protoxide of lead which seems to flow from the electrode like a sort of white pulp.

If the negative electrode is of mercury, we see the free surface of this metal become covered with pasty protuberances having the brilliancy of mercury; these give off hydrogen, and more than an hour after the cessation of the current they give off more.

Aluminium is violently attacked at the negative pole, it changes into alumium, and after a certain time the metal loses all cohesion, crumbles and falls to the bottom of the vessel in the form of grey flakes and grey dust.

These experiments, and especially that relating to aluminium, lead me to the conclusion that metallic hydrures are formed at the negative pole, which the water destroys upon the formation of oxide and the liberation of hydrogen.

WILL ELECTRICITY SUPPLANT GAS?

A VERY important question which is now being frequently asked, not only by the public, but also by gas companies, both private and municipal, is as to whether electricity as an illuminant will ever entirely supersede gas. Probably a good deal of light may be thrown upon the subject by considering another query, namely, Why is such a question asked? This is certainly less difficult to solve than the former, and we will therefore deal with it at the outset. In the first place, we hear on all sides throughout the country of numerous notices being sent in by electric supply companies to the local authorities, informing them that they intend to apply to the Board of Trade for provisional orders for the supply of electricity, and asking for permission to supply current in the district concerned. (It may here be remarked that the time for sending in applications for provisional orders during the present session of Parliament expired a few weeks ago.) This action of the various companies—many of which are not in a position to furnish current for some time to come, inasmuch as most of them have only just been registered, and have but little capital subscribed—seems to be greatly due to the fact that they fear that if they do not take action in the matter, either the municipalities themselves, or some other company or private firm, will apply for a concession for the same district or town, as the case may be. This has been demonstrated by several companies giving notice to the same local authority, applications having been sent in by no less than six companies in two or three instances. Then, again, some of the electrical companies appear to be alive to the fact that if they do not take steps to supply electrical energy, the gas corporations will probably themselves take the matter in hand. There are already instances of this having been attempted. One is in the case of the Dublin Gas Company, which under the Act of 1866 was empowered to supply gas and "other improved means of lighting," but the company's Act was amended by the Act of 1883, under which the permission of the Board of Trade was required before the company could exercise its powers under the former Act. It will be remembered that Major Marindin recently advised the Board of Trade that it was not advisable to accede to the request of the Dublin Gas Company to be allowed to exercise its powers of breaking up the streets for the laying of electric light mains. Another instance of the growing eagerness of gas companies to supply electricity is that of the Benthen (Germany) Gas Company, which offered to light a portion of that town gratuitously for a certain period; whilst it will possibly scarcely be necessary to mention the Imperial Continental Gas Association of Vienna, which not only supplies gas, but also the electric light. Other cases might be found, but those already cited are sufficient to show that the suppliers of gas—we will not follow the example of Major Marindin and other officials of the Board of Trade and use the ghastly term "undertakers," as was done in connection with the London provisional orders—are fully alive to the very important *rôle* which electricity will ere long play for both lighting and power purposes. Another reason which may be advanced as one of the causes of the interest manifested by gas suppliers in the matter is that they already have many facilities, such as site, plant, distributing facilities, and the command of capital. This is all very well in its way, but we are strongly of opinion that gas companies will, if they desire to supply the electric light, have to obtain powers to do so just in the same manner as electric lighting companies. Now, although under the Acts by which they are controlled gas companies are empowered to supply gas and "other improved means of lighting," it is generally considered that as electricity as a lighting agency was scarcely known at the time of the passing of those Acts, the latter cannot be said to apply to the electric light in the phrase "other improved means of lighting." Time, however, will show whether our theory is correct or otherwise. We cannot, however, admit, as was recently contended by the *Gas and Water Review and Journal of Electric Lighting*, that the before-mentioned facilities are of such a nature as to place gas companies in a more favourable position as regards supplying current than new electric lighting companies. If the former take up the supply of electricity, they will have to employ a special staff to do nearly the whole of the work, and unless *carte blanche* be given to the chief electrical engineer—which it is extremely improbable would be the case—who must be a first-class all round man, and to whom a high rate of remuneration would have to be paid, they might find themselves even in a less satisfactory position. We have, however, come to the conclusion that they could not furnish electrical energy at a cheaper rate than electrical companies. The other gas journals, too, notwithstanding their animosity to electrical progress, find it impossible to resist the temptation of dealing with electrical matters. Hence we find that week after week they devote considerable space to the subject, knowing, as they do, that if they boycott the matter, they will, sooner or later, be left in the cold.

It will be obvious from the foregoing that the conclusion arrived at by electrical engineers as to the leading part which electricity as a lighting agency will in the near future play is forcing itself upon the minds of most people in this and other kingdoms. That being the case, let us see to what extent electricity will be employed, and if it will entirely supersede gas. The enormous development which is taking place in this and other countries points conclusively to the fact that thousands of householders and business men are adopting the electric light in preference to gas. In London, now that the provisional orders granted to the various metropolitan companies have been confirmed, we may expect to see within the course of two or three years a complete transformation in the mode of lighting, one company alone making provision for the supply of current for 2,000,000 lights, whilst the others are also moving in a similar manner, although on a smaller scale. Does this imply that the enormous number of lights which will be furnished will supplant gas as an illuminant? It is rather difficult to answer. Certain it is that many of the present consumers of gas will, on the installation on their premises of the electric light, cease to use gas, and in these cases it is evident that there will be a reduction in the consumption of the latter commodity. With the exception of the greater portion of the City, and the whole of the East of London, nearly all the metropolitan districts will at

no very distant date be supplied with the electric light, and the number of establishments which will avail themselves of it is, as far as we have been able to ascertain, very considerable. It will therefore be obvious that the gas companies know, or ought to know that there will be a considerable diminution in the consumption of their illuminant. There will, however, be hundreds—we might, perhaps, truthfully say thousands—of streets, &c., in the houses and establishments of which the electric light will not be installed, because the price at which electrical energy can at present be supplied is prohibitive to its use in the poorer neighbourhoods. This will be especially the case as regards the eastern portion of the metropolis, to which the companies appear to have wisely given a wide berth. In those districts, moreover, where installations will be put up, there will naturally be many shopkeepers, &c., who cannot afford to pay for current, the maximum price of which is 8d. per Board of Trade unit, as fixed by that department. This price corresponds to about 6s. 8d. per thousand cubic feet of 16 candle-power gas, so that to bring the price down to that charged for gas —taking the rate of the latter in London at 2s. 6d. per thousand—it would be necessary to sell electrical energy at the rate of 3d. per Board of Trade unit, which figure is, of course, at present impossible. Therefore, those shopkeepers situated in the immediate districts of electrical distribution, and who are not in a position to pay the higher rate, will consume more gas, and it is in this respect that the gas companies will, to an extent, be partly recouped for the decrease in the use of gas by its present consumers, many of whom will soon substitute electricity for it. Where the electric light is installed, those establishments near using gas will appear exceedingly badly illuminated, and the result of this will be that they will have more gas jets put up to partly make up for the apparent dimness of their premises as compared with those in the neighbourhood which are electrically lighted. This has been demonstrated in several instances in some provincial towns, and it is fair to assume that the same state of affairs would hold good in London. After considering the effects on the consumption of gas which the future development of electric lighting in the metropolis will have, it will hardly be necessary to refer to the provinces, since the same results would be arrived at. The conclusion we have come to on this important subject is that there will always be a certain section of the community which will be unable to pay for the electric light, just the same as many persons cannot at present afford gas; and we may therefore be pretty sure that the electric light will not, as far as our present knowledge of electricity goes, entirely supersede gas, although it will cause a decrease in its consumption as a purely lighting agent.

ARC LIGHT CARBONS.*

By LOUIS B. MARKS.

ALTHOUGH in all probability a great amount of work has been done upon the subject, the publication of *facts* concerning the modes of manufacture, the laws of candle-power, life and efficiency of arc-light carbons has, until recently, been very limited in extent.

It is not proposed in this brief sketch to go fully into these matters but merely to mention, among other things, a few facts heretofore unpublished, throwing some light on this important subject.

The question has been asked,† in what manner and to what extent the size of the carbon affects the results in a current of given strength, covering of course, in the general question of conductivity, the all-important results of light and life.

The conclusion has been drawn from a multitude of experiments that with carbons of the same manufacture and type the *life of the carbon varies directly with its diameter and inversely with its resistance.* Thus the life of a one inch Brush carbon having an actual diameter of ·986 inch and a resistance of ·061 ohm is, according to test, 26·15 hours. According to the law above stated the life of a $\frac{5}{8}$ inch Brush carbon having an actual diameter of ·618 inch and a resistance of ·0735 ohm would be by calculation 13·62 hours. When put to test, this carbon burned 13·64 hours. Many other examples might be given here but lack of space prevents. In the law stated above it is understood that the relation holds true only when the current and the difference of potential between the terminals of the lamp are kept constant in all cases.

We are in the habit of referring to those systems in which a small current and a long arc are used as high tension systems, and those in which a large current and a short arc are used as low tension systems. It has been found that, generally speaking, a *moulded* carbon is superior for high tension and a *forced* carbon for low. Forced carbons are made by pressing the mass through a die of given size after the fashion of "squirting" lead pipe. The following figures speak for themselves:

Tests of Efficiency.

		Per Cent.
High tension	$\frac{1}{4}$ inch moulded carbon; efficiency	= 11·71
	$\frac{1}{4}$ inch forced " "	= 8·88
Low tension	$\frac{1}{4}$ inch moulded " "	= 9·32
	$\frac{1}{4}$ inch forced " "	= 11·05

From the candle-power and efficiency tests of carbons it has been determined that the efficiency of a copper plated carbon is exactly the same as that of an unplated carbon of the same diameter, although the life of the former be from 30 to 40 per cent. longer than the latter.

THE FIVE-LEAD SYSTEM.*

By Dr. KRIEGER, Government Architect.

WE have no sense which affords us a direct perception of electricity. If we could see it we should have a continual view of infinite change and variety, for everywhere, in the clouds as in the earth, in every chemical transformation, there occur electric currents without number. But we are unable to behold the play of these phenomena, and thus our conception of the nature of electricity is but imperfect. Still, we work with it, and its technical applications on the large scale increase from day to day. Before long Königsberg will be supplied with the electric current from a central station, both for lighting and for driving large and small machinery. Hence the manner in which this is to be effected is full of interest. If we wish to arrive at a clear understanding of the conditions we must, in default of direct perceptions, study them in a similitude, which is not hard to find. Imagine an elevated tank from which water is lead through mains to a turbine at a distance, and you have an image of the electric current. In place of the turbine you have only to suppose a machine or a lamp actuated by electricity; the height of the water level completely corresponds to the potential of the electric current above the earth. The electricity is raised in tension above the electric level of the ground by the use of dynamos (comparable to pumps), or by the use of elements, just as the water-level of the elevated tank is raised above that of a large reservoir. If we imagine the mass, or rather the inertia of the water removed, and consider merely the flow to a lower level, the representation is complete. If we now return to our simile we may, if we have to do with small

* Abstract of Thesis.—Cornell *Crank*.

† Paper read before National Electric Light Association, by F. W. Parker, February, 1888.

* Abstract of paper read before the New Polytechnic Society of Königsberg, on June 19th, 1889.

quantities of water only, allow it after it has been used to flow off into the gutter, without enquiring how it finds its way into the earth. But, on the large scale, provision must be made for a regular outflow, and along with the water supply there must exist a water discharge. Just so with electricity. Small quantities, after they have fulfilled their duty may be let escape directly into the earth, as in the case of the electric telegraph. For considerable quantities the escape plates would be too large, and a special return lead must therefore be arranged. The greater the quantity of electricity which a lead has to convey the thicker it must be made, and for a double number of lamps which have to be served the section is generally doubled. When a great number of lamps have to be connected, the expense of the copper leads becomes very considerable. Lately it has been found possible, by means of a peculiar device, to multiply the number of lamps to be supplied without increasing the quantity of copper in anything like the same proportions. Turn your minds again to the water course and suppose it requisite to drive a double number of turbines with the same quantity of water. In such a case we must pump up the water to a double height and arrange the turbines in two stages, one above the other. The same water which drives an upper turbine drives also a second placed below it. Just so with electricity, if we take the lamps of a light installation in place of turbines. We can, with leads of the same section, supply a double number of lamps, if on the one hand the tension of the electricity is raised to a double potential, and if two lamps are fixed in series. To this end a third lead is placed between the two usual ones, and the lamps are equally distributed in the two divisions thus produced. As long as an equal number of lamps is burning in each division each lamp receives a sufficient current. But if we now return for a moment to the turbines fixed in two stages the one above the other, and suppose that the number of the upper turbines is smaller than that of the lower ones, whilst each turbine requires the same quantity of water for proper work. In this case the water flowing away from the upper stage will not suffice for the lower. But in this case, also, normal work is possible if a special water pipe brings to the lower turbines exactly as much water as will make up the deficiency; if the number of the upper turbines is greater than that of the lower stage the same pipe may serve to carry off the excess of water which comes down from the upper turbines and is not used by those below. Just the same with the lamps. If the middle lead returns to the central station it can, if the two divisions are unequally burdened, either bring or convey away as much electricity as is needed to supply the lamps which are burning in one division over and above those in the other. Experience shows that in a large installation, such as that of a town, approximately an equal number of lamps will be burning in each branch, and that the highest occasional difference will not be more than one-third of the maximum number of lamps burning in either branch. Hence the extra lead requires to have only one-third of the section of each of the others. Such a system consisting of a flow—a return—and an intermediate lead is called a "three-lead" system. Suppose the lamps now fixed serially, not in two, but in three branches, we have then a four-lead system. If the number of the branches is increased to four, we have the "five-lead system," such as is about to be introduced into Königsberg. Along all the streets there will be laid five parallel leads. The two outer ones will convey the entire current, when all the four branches are equally burdened. The three intermediate, thinner leads, will convey a current only if more or fewer lamps are burning in one branch than in another. In spite of the number of the leads such a five-lead system is decidedly cheaper than a two-lead system, requiring only about the tenth part of the copper. A part of the economy is certainly again counterbalanced by the increased demand for insulating material, but the saving is still very considerable.

THE ELECTRIC LIGHT AT THE ST. LAZARE RAILWAY STATION, PARIS.

[BY A CORRESPONDENT.]

THE St. Lazare Station and its dependencies, which have lately been rebuilt, have been prepared in order to be lighted by electricity, the installation being made by the Electric Light and Apparatus Company, which has secured the lighting contract. The suburban platforms and those of the main line, as well as the inner passage which unites them, the vestibules, the Grand Salle des Pas Perdus to the first floor going from the Rue de Rome to the Rue d'Amsterdam, the waiting rooms, the quays, and the ways under the covered markets up to the bridge on the Place de l'Europe, and, finally, the luggage rooms on the main line arrival platforms. The whole of this lighting is to be furnished by: 100 incandescent lamps of 10 and 16 candles, 153 arc lamps of 40 carcels, and 18 arc lamps of 25 carcels.

The Western Company, according to *Le Génie Civil*, has reserved the right of varying the number and placing of the lamps; the installation of the motive power permitting of raising to the following figures, if it be judged useful, the number of lamps indicated above:—

For the incandescent lamps of 10 to 16 candles ...	125
„ arc lamps of 40 carcels	175
„ arc lamps of 25 carcels	20

The station which produces the current is placed on a piece of ground situated at the head of the Batignolles tunnel. Three Belleville generators, capable of supplying 2,000 kilogrammes of steam per hour, feed three Lecouteux and Garnier engines of 140 horse-power, making 180 revolutions a minute. Each of these engines works two Gramme dynamos of 450 ampères and 100 volts, connected in series. Two groups suffice for the lighting, the third being held in reserve.

The canalisation between the station and the central post is composed of cables of 200 square millimètres section, the covering of which varies according to the successive positions which they occupy. From the station to the Place de l'Europe bridge, the cables are lead-covered and repose on supports of galvanised iron; beyond, up to the head of the quays, the cables are braided, and kept up by porcelain insulators fixed on supports analogous to those preceding; from the head of the quays to the distributing table the cables are lead-covered. The secondary canalisation joining each arc lamp to the distributing board of the central post is made of braided cables, of a section of 3 to 5·5 square millimètres, according to the distance from the lamps to the board. Some lead-covered cables, of a section of 3 square millimètres, are placed in a trench in creosoted wood tubes for the upper part of the circuit which supply the platforms. The silicious bronze cables of 7 square millimètres, supported by porcelain insulators, serve the open part of the circuits of the lamps placed on the lines.

Among the lamps of 40 carcels 43 are in the open, and are thus divided:—1. On the lines, 7 behind the footbridge commanding the signals, &c.; 6 to the right of this footbridge and by the side of the markets; 7 to the right of the glazed panel which encloses them. 2. 23 on the footways of the building *en façade*, on the Courts de Rome et d'Amsterdam and the periphery of the terminus hotel. The 110 other lamps are under cover: 10 light the Salle des Pas Perdus to the first floor, and 89 are appropriated to the lighting of the markets, the waiting and luggage rooms, and the main line arrival platforms. Under the markets there has been adopted an arrangement in a more or less regular quincunx, so as to specially spread the light on the two lines of revolving plaques which ensure transversal communication between the quadruple line groups and on the heads of the suburban lines where the turning of the locomotives takes place on the arrival of each train.

The last 11 lamps of 40 carcels, under cover, are given over—1 to the luggage room and the suburban departure platform, and the other 10 to the lighting of the vestibule and the main line luggage rooms. The 18 lamps of 20 carcels are sheltered, and used in the cellars of the Salle des Pas Perdus and on the periphery

of the terminus hotel. The prices stipulated are as follows, per lighting hour, for each kind of lamp :—

	Francs.
1. For the incandescent lamps of 10 candles ...	0·05
2. „ „ „ 16 „ ..	0·05*
3. For voltaic arc lamps of 25 carcels	0·30
4. „ „ 40 „	0·40

In case the Western Company should deem it useful to employ voltaic arc lamps of a power superior to that indicated above, the price per hour of lighting for the lamps of 40 to 120 carcels would be calculated at the rate of 1 centime multiplied by the number of carcels representing the luminous intensity of the lamp. The duration of the agreement is fixed at 10 years, at the expiration of which the company will enter into possession of the installation without any reimbursement to be made to the working company. This lighting works in the most regular way and to the satisfaction of everyone; the lamps are judiciously divided, and shed everywhere a light comparable to that of open day, without sensibly raising the temperature of the *salles* and *couloirs*.

Apropos of the electric light in Paris, a most important discussion has just taken place before the Paris Municipal Council. This discussion arose on the subject of the employment of machinery and apparatus constructed abroad, and used by certain concessionary electric lighting companies contrary to the stipulations accepted by them. These stipulations imposed in an absolute manner the employment of machinery, apparatus, and cables of French manufacture. The non-observation of these stipulations led to an exchange of opinions, and the subject was eventually referred to a committee to inquire into the charges. At the same sitting the Municipal Council voted the enlargement of the section of one of the companies which divide the electric lighting between them. The company holding the concession for the Place de Clichy section was granted an extension to the Boulevard Haussmann and the Parc Monceau, if the deposit of 100,000 frs. be made. This increase is not so large as that asked for by the company, but the portion asked for and not granted has been referred to a committee for further consideration.

TRANS-ATLANTIC CABLE ROUTES.

WE have received, by favour of Mr. Gisborne, of the Canadian Government Telegraphs, the following advance proof of an article which was to appear in the Montreal *Dominion Illustrated* of July 20th :—

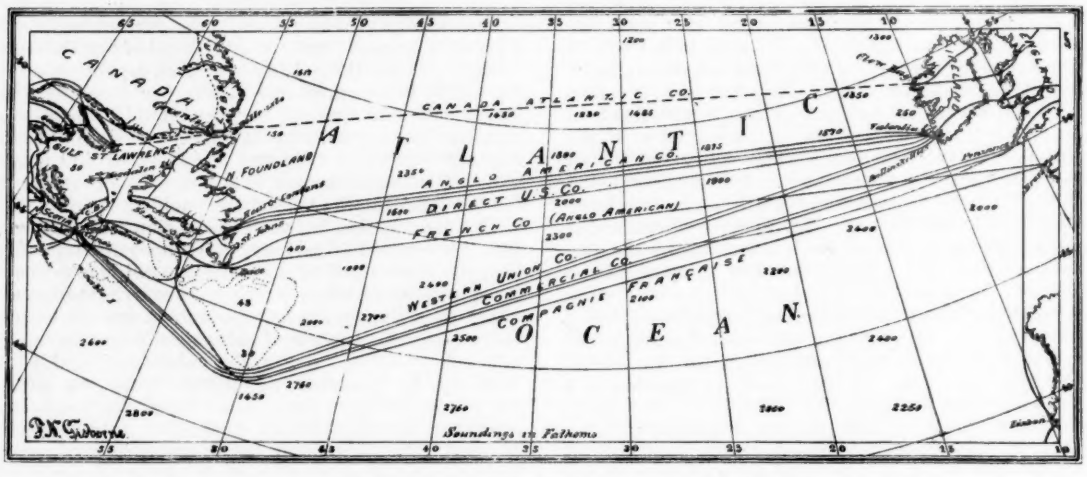
The accompanying map shows the relative lengths and approximate positions of trans-Atlantic submarine electric cables in present operation; also, the proposed Canada-Atlantic cable *via* the Straits of Belle Isle, viz. :—

The Anglo-American Company's Cables.

Laid.	Between.	Nautical miles.
A.D. 1873.	Ireland and Newfoundland	1,881
„	Newfoundland *viâ* St. Pierre and Cape Breton...	293
		——2,174
A.D. 1874.	Ireland and Newfoundland	1,840
1873.	Newfoundland and Sydney, C.B. ...	343
		——2,183
A.D. 1880.	Ireland and Newfoundland	1,886
„	Newfoundland *viâ* St. Pierre and Cape Breton	360
		——2,246
A.D. 1869.	France and St. Pierre	2,648
„	St. Pierre and Massachusetts, U.S. ...	759
		——3,407

The Direct United States Company's Cables.

A.D. 1874.	Ireland and Nova Scotia	2,423
„	Nova Scotia and N. Hampshire, U.S...	560
		——2,983



—— Telegraph lines and cables in operation. - - - - do. projected.

Compagnie Française Paris à New York.

A.D. 1879.	France and St. Pierre	2,242
„	St. Pierre and Cape Breton	188
„	St. Pierre and Massachusetts, U.S. ...	827
		——3,257

The Western Union Company's Cables.

A.D. 1881.	England and Nova Scotia	2,531
1882.	England and Nova Scotia	2,576

The Commercial Company's Cables.

A.D. 1884.	Ireland and Nova Scotia	2,350
„	Nova Scotia and New York, U.S. ...	841
		——3,191
„	Ireland and Nova Scotia	2,388
1855.	Nova Scotia and Massachusetts, U.S.	519
		——2,907

The Canada-Atlantic Company's Cable (Proposed).

A.D. 1890.	Ireland to Straits of Belle Isle, Can....	1,900

The representative expenditure or share capital of the foregoing companies is approximately as follows :—

Anglo-American ...	... $35,000,000	—Each line...	$8,750,000
Direct United States	... 6,400,000	„ „	6,400,000
Compagnie Française	... 8,400,000	„ „	8,400,000
Western Union ...	... 14,000,000	„ „	7,000,000
Commercial ...	... 8,000,000	„ „	4,000,000
Canada Atlantic ...	... 1,600,000	„ „	1,600,000

It is estimated that the *profitably* serviceable continuity of the foregoing cables will be 20 years for the older and 25 for the later types; last year's costly ex-

* This is probably an error.—EDS. ELEC. REV.

perience in repairing the Anglo-American French cable of 1889 is confirmatory of the former calculation.

Thus the three additional cables of the Anglo-American Company have a prospective existence of 4, 5 and 11 years respectively, and it is evident that the hitherto controlling power of the company, *re* tariff and pooling dictation, is an evil of the past.

The Direct United States cable has yet a prospective profitable career of five years; the Compagnie Française 10 years; thus the Western Union and Commercial companies, with their later cables of longer life, have control of the situation, as exemplified by the present established tariff rate of 25 cents per word.

A glance at the explanatory map will show how dangerously close together existing cables now lay upon the bed of the ocean, not unfrequently crossing each other westward of the banks of Newfoundland. Indeed, if the true history of repairing expeditions, both in deep and moderate soundings, was made public, the facts would be not a little startling to shareholders.

It is with a full knowledge of all the foregoing and other data that the direct Canada-Atlantic cable (from Ireland or Scotland, *via* the Straits of Belle Isle) has been projected, as possessing the following decided advantages over all established lines:—

1. The Belle Isle route will be over 150 miles northward of any trans-Atlantic cable now laid, and the depth of ocean (*vide* map) will be considerably less; it will thus be absolutely free from all risks during the repairs of other cables, and can be more readily raised when required.

2. The company have only to provide and maintain the main cable or cables, of not exceeding 1,900 miles in length, the connection eastward being with the Imperial Government Post Office telegraph service, and westward with the Canadian Government telegraph service at Greenly Island in the Straits of Belle Isle. Hence, the company will be at no outlay of capital for terminal cables, and no pooling pressure, &c., is practicable.

3. The capital expenditure of the company will not exceed $1,600,000, one of the principal cable manufacturing company's in London having tendered to provide, lay, and guarantee a cable of the most approved type for the sum of $1,500,000. Thus the company's line will cost less than $\frac{1}{3}$th of each Anglo-American cable, $\frac{1}{4}$ that of the Direct United States, Compagnie Française, and Western Union lines, and a little over $\frac{1}{3}$rd that of the Commercial Company's connections.

4. The company's annual maintenance charges, as compared with those of other cable companies, will be very moderate. For instance, per last semi-annual report of 1888, the Anglo-American Company's London head office expenses amounted to over $30,000, and station expenditure to over $158,000—in all, $188,000; and the Direct United States Company's to $15,000 and $50,000 respectively—in all, $65,000. Estimating $30,000 as the maximum expenditure of the Canada Atlantic Company upon similar account, the economy in that way alone will be equal to a dividend of from 1 to 3 per cent. upon the company's capital.

5. The British Admiralty chart proves that to the northward, around Belle Isle to Greenly Island, there is a deep water channel, protected by reefs and sand bars 30 fathoms below the surface. Icebergs very occasionally ground in 30, but never exceeding 40, fathoms around the coasts of Labrador and Newfoundland. Thus it will be seen that the cable approaches to Greenly Island are quite as safe as to any other point on the coast of North America.

6. The present number of trans-Atlantic despatches relating to Canadian business alone average 800 per day, and are rapidly increasing; and should the proposed Japanese, China, and Australian trans-Pacific cables be laid, the business will be almost infinitely added to.

Finally, despite inflated capital and immense annual expenditure, the Anglo-American Company have lately paid interim dividends of $2\frac{1}{2}$ and 5 per cent. upon $22,000,000 of their capital stock, and the Direct Cable Company $3\frac{1}{2}$ per cent. upon $6,400,000; thus proving that the Canada-Atlantic could have paid, during the same period, at least 15 per cent. upon their capital.

No further argument is required to prove that the Canada-Atlantic Company can *command* their own fair share of business, as they can well afford to reduce the total rate per word, or to increase the proportion per word that is allowed to connecting land lines by the existing cable companies.

NOTES ON THE DYNAMOS AT THE PARIS EXHIBITION.

III.

ANOTHER noteworthy exhibit from Switzerland is that of Messrs. R. Alioth et Cie, of Bâle, who make a good show of dynamos, arc lamps, regulating apparatus, &c. In fig. 1 is shown one of the machines we saw at work, a section through its field magnet being given in fig. 2.

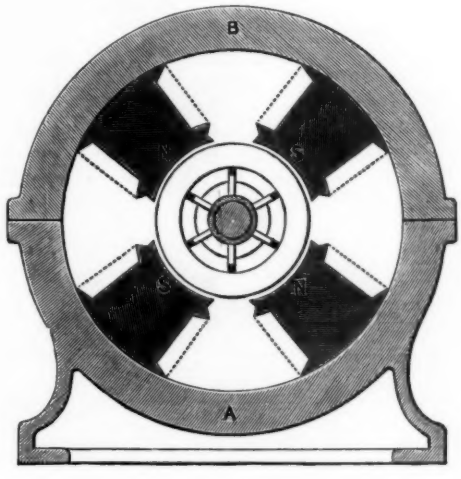


FIG. 2.

It is shunt-wound, and generates at a speed of 400 revolutions per minute, a current of 240 ampères having a difference of potentials at the terminals of 120 volts. The machine is of the four-pole type, having the radial magnets, N, S (fig. 2), carrying the magnetising coils, fastened to a heavy circular yoke ring, A, B, made

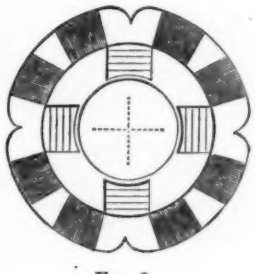


FIG. 3.

in two pieces. The lower half, A, is cast in one with the bedplate, the upper being jointed to it horizontally, as shown. The magnets, which taper a little on the sides as in the fig., are of cast iron, and are secured to the yoke ring by screws tightened from the outside, their heads being countersunk into the metal on the exterior of the ring. The area of each magnet at its largest section is about 115 square inches. The armature core is built up of soft iron washers, $\frac{1}{16}$th of an inch thick, insulated from each other by paper, and mounted on a gun-metal frame in groups of six, the washers of each group being rivetted together, and a

space of $\frac{1}{2}$th inch left for ventilation between adjacent groups. The core is 14 inches in diameter outside, and has an opening $9\frac{1}{2}$ inches diameter, its length being $19\frac{1}{2}$ inches. The winding is of the drum class, the conductors being on the exterior of the armature only, and each coil, before it is placed on the surface of the core, being shaped independently on a wooden mould. There are 90 coils, each having one convolution, which embraces about one-fourth of the circumference. This makes 180 conductors counted all round the armature periphery, these being of rectangular copper wire, 4·5 mm. wide by 6 mm. high, insulated with wrappings of silk ribbon. The conductors do not completely cover the core, and ample ventilation is therefore secured by the draught of air passing between the adjacent groups of armature washers. The machine described has a commercial efficiency of 88 per cent. The weight of copper on the armature is 110 lbs. The magnets are wound with insulated copper wire, 2·7 mm. in diameter, in 2,600 convolutions, the length being 4,500 metres. The weight of copper on the magnets is 507 lbs., and the total weight of the machine 6,172 lbs. The coils are connected up to a ninety-part commutator, which has brass bars insulated with paper. The bars are cross connected, and the current is collected by two sets of brushes 90° apart.

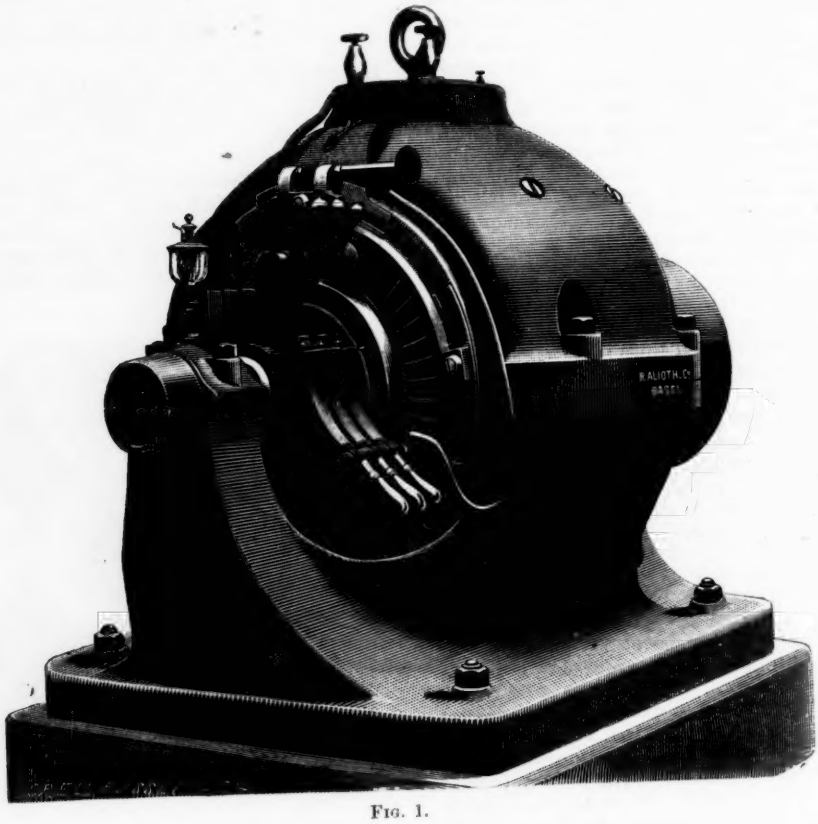


FIG. 1.

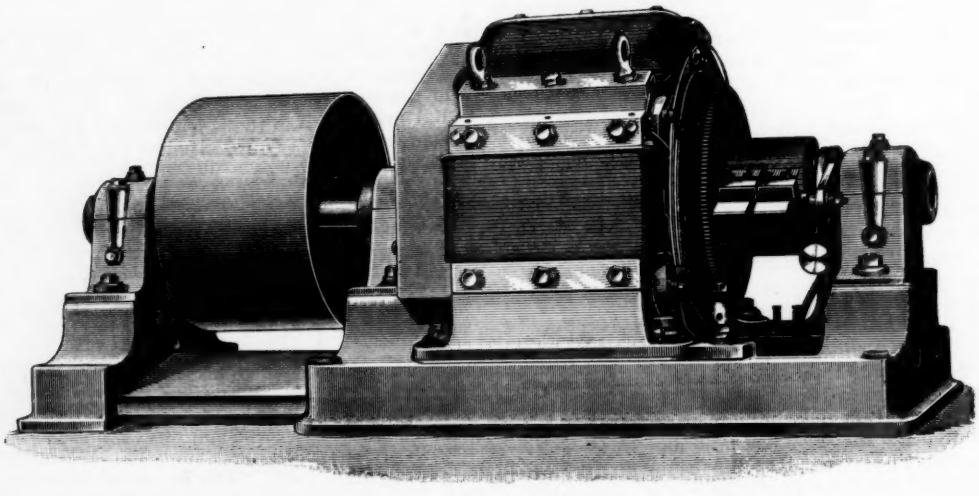


FIG. 4.

The method of obtaining the necessary pressure of the brushes on the commutator will be understood from fig. 1. The gun-metal casting which holds the brush is secured to the end of a long compound spring, formed by two outside plates or ribbons of brass, containing between them a number of thinner copper ribbons. The other end of this spring is attached to a boss which fits on the supporting stud, there being screwed into

this boss a handle, by the movement of which the pressure of the brush can be adjusted to any desired amount, and which by giving it a turn after adjustment serves as a set screw to keep the boss in position and the pressure constant. The current is conveyed from the brush through the spring to the supporting stud, and the contrivance is both novel and simple. In our illustration there are three brushes in each set, each brush having a separate spring and adjusting handle. In some of the machines there is substituted for the spring holder one in which the pressure of the brush may be adjusted by a weight sliding on a lever arm standing out from the boss on the stud. The angular position of the brushes on the commutator is adjusted by rotating the gun-metal perforated plate which carries the supporting studs, by means of the worm and hand wheel shown at the top of the machine. Brushes of copper gauze are used, and we noticed that in several of the commutators the material employed for insulating the bars was red vulcanised fibre.

In the compound machines exhibited the field coils are wound both on the yoke ring and radial cores. The sketch in fig. 3 shows how the winding is disposed, the series coils being wound on the radial cores and the shunt coils on the ring. These machines have on each side of the field magnet castings gun metal brackets to carry the armature bearings, and are each provided with a flywheel and mounted on a bedplate furnished with belt-tightening screws.

In the series machines for arc lighting the coils are not connected singly to the commutator bars as in the incandescence machines, but are, before connecting up, coupled internally two in series, opposite commutator bars being, of course, connected together. The current in the series armatures splits, therefore, into two parallels instead of four, as in the incandescence machines, and the E.M.F. is twice as much as it would be were the coils connected to the commutator bars singly.

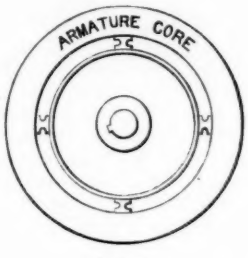


FIG. 5.

Another Swiss firm whose exhibits deserve favourable notice is that of Messrs. Cuénod Sautter et Cie, Geneva. This firm manufactures the Thury dynamo, which is well known on the Continent, and of which we give an illustration in fig. 4. Occupying a conspicuous position in the Palais des Machines, a six-pole dynamo of this type may be found, its capacity being given as equal to 3,200 lamps of 10 candle-power, or 2,000 lamps of 16 C.P. The normal speed of this machine, which is shunt wound, is 360 revolutions, at which it gives 750 ampères at a difference of potentials of 140 volts. The resistance of the armature is given by the makers as ·0043ω, the yield and efficiency under test being as follows :—

Speed = 360 revs. per min.	Spent in field coils = 1,568 watts
Current = 750 ampères.	Spent in armature = 2,430 ,,
D. of P. = 140 volts.	Spent in mechanical friction, hysteresis and parasitic currents ..... = 2,800 ,,
Output = 105,000 watts.	
Total power absorbed = 111,798 watts.	

$$\text{Commercial efficiency} = \frac{105{,}000}{111{,}798} = \cdot 938 \text{ or } 93{\cdot}8 \text{ per cent.}$$

The armature core is built up of soft iron washers ·4 mm. thick, insulated by paper. Keyed to the shaft (fig. 5) are two cast iron supporting wheels, one at each end of the armature, upon the peripheries of which rest the ends of four longitudinal key pieces of gun metal which carry the armature core. The armature winding is of the Siemens type, as modified by M. Thury, the coils being in this machine coupled up to a commutator having 135 bars, and the current being collected by eight copper plate brushes each 3 inches wide. It will be noticed that the illustration, fig. 4, shows only two sets of brushes, the number used depending entirely upon the current to be carried. The commutator bars

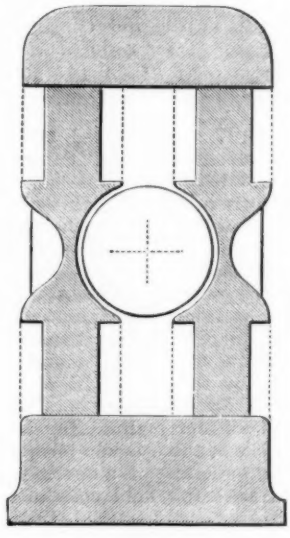


FIG. 6.

at the same potential are cross connected, so brushes may be put on at discretion. The magnet cores and pole pieces are both of wrought iron, the field magnets forming, when put together, a hexagonal frame, as shown. There are 286 lbs. of copper wire on the armature and 1,328 lbs. on the magnets, the total weight of the machine being 15,432 lbs.

Messrs. Cuénod Sautter et Cie have kindly handed us the particulars of a smaller six-pole Thury machine for an output of 88,000 watts. This machine runs at 300 revolutions per minute, and gives under full work 800 ampères at a difference of potentials of 110

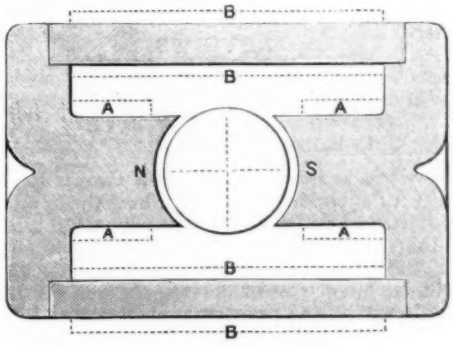


FIG. 7.

volts. Again the current is carried by eight brushes each having a width of 3 inches. The armature coils are 111 in number, connected up to a commutator having 111 bars. Each coil has one convolution of six wires in parallel 2·9 mm. diam., these being laid on the armature in two layers. The area of conductor is thus 6 × 6·6 square millimetres per coil; or, since the current in a six-pole machine splits up into six branches,

the total area for 800 ampères is 36 × 6·6 = 237·6 square millimetres. This corresponds to a current density of about 2,170 ampères per square inch. The armature has a resistance of ·0033 ohm at 30° C. The field magnets are wound each core with 490 turns of 3·7 mm. diam. wire, the total turns therefore being 2,940, having a resistance of 7·63 ohms at 22° C., and measuring 4,760 metres. The bore of the magnets is 750 mm., the outside diameter of the armature 747 mm., and the diameter of the armature core 731 mm. The length of the armature is about 800 mm., and its core has a cross section of 530 square centimetres, while the magnet section is 560 square centimetres. The average length of the path of the induction for each magnetic circuit is 980 mm., and the ratio of the circumference of the armature covered by the pole pieces to the part uncovered is 3·33 to 1. The total weight of this machine is 9,900 lbs.

In figs. 6 and 7 are sketched two types of field employed by Messrs. Cúenod Sautter for two-pole machines. Fig. 6 is of the double horse-shoe type, and constructed wholly of cast iron, there being four magnetising coils in the positions shown by the dotted lines. The magnets of fig. 7 appear to be a combination of wrought and cast iron. The side cheeks with their cores are castings, the top and bottom bars being, we surmise, wrought iron. The photograph in our possession appears to have been taken from a compound machine, two shunt coils being wound on the cast iron cores as shown by the dotted lines at A, A, and two series coils on the wrought iron bars as shown at B, B.

Several regulators for maintaining a constant difference of potentials at the dynamo terminals are shown; these consisting generally of a device whereby a resistance in circuit with the field coils of a shunt wound dynamo is increased or diminished. In some, mechanism driven from the dynamo spindle or a countershaft is employed, with a gearing so designed that the lever of a rheostat may be caused to move in either direction, to insert or take out resistance, or remain out of gear and at rest. The direction in which the lever moves is determined electrically by the action of an iron core in a solenoid wound as a shunt to the terminals of the dynamo. So long as the difference of potentials remains normal the iron core does not move and the rheostat lever remains at rest, but when the potential rises the movement of the core gears to the rotating mechanism the lever which then inserts resistance into the circuit until the potential becomes normal. If the potential falls the lever is made to turn round in the opposite direction and resistance is taken out.

(*To be continued.*)

REVIEWS.

Electricity applied to the Military Art. By Colonel GUN. (*L'Electricité appliquée a l'Art Militaire.*) Paris: J. B. Baillière et Fils.

This work is interesting from a two-fold point of view. On the one hand it shows how the applications of electricity to practical purposes are multiplying and extending. On the other hand it shows, if any such demonstration is still needed, how, in spite of peace societies and congresses, and suggestions for international disarming, the proportion of skill and invention applied to the wholesale destruction of human life is evidently on the increase.

The author, who bears the very appropriate name of Gun, discusses in succession the methods of igniting explosives used in war, under which head he describes apparatus for generating electricity of high tension, such as the devices of Ebner, the pyrotheque, the machines of Siemens, Breguet, of Marcus, Ducretet, L. de Place, and Bassée.

He mentions that the French Government has abandoned tension-primers and exploders on account of the induction effects which they are liable to produce. Thus when it is, *e.g.*, desired only to explode one submerged torpedo, others, which are not within range of an enemy's ship, may be discharged simultaneously. England and Germany still retain these primers.

A very ingenious telephonic method for testing the primers is described at some length.

The second chapter is, strictly speaking, a digression. It gives an account of the explosives at present in use. We find here a list of patented compounds drawn up by Col. Bucknill, R.E. The author makes, however, certain additions. Thus of Melinite he says: "A French war explosive, the composition of which we know, but which we shall avoid giving here, though it is asserted that the secret has just been sold to England by the inventor." The composition of the smokeless explosive, "powder B," adopted by General Boulanger, is kept secret "from the same patriotic motive."

We cannot help remarking that whilst foreign nations seem able to keep their military improvements concealed Britain rarely fails to show any secret which she may have acquired even to representatives of powers which, in case of war, would very probably figure as her enemies.

Chapter III. treats of land-torpedoes, of bombs let fall from ballocns, of river torpedoes, of the destruction of bridges and of railways. Electricity is not invariably used in these operations.

The second part of the book is devoted to the organisation of military telegraphy in France and abroad. The author observes, "we see the development which has ensued since the beginning of the century, when the telegraph served only to convey to Paris the tidings of our victories. Let us hope that, these heroic times returning, the staff of the French military lines will again have to telegraph the exploits of our brothers in arms!" No very peaceful aspiration!

A following part describes the military telephone and microphone. In the brief historical sketch we see that the invention of the speaking telephone is unhesitatingly ascribed to Graham Bell.

The fourth part takes up military optical telegraphy, under which are included the old semaphore and the new method of sending signals by flashes of light. Whilst conceding that this method of transmitting intelligence has in actual warfare great advantages over the electric telegraph, he points out as a defect that no copy of the despatch is preserved, and proposes to this end certain methods. His objections to the use of photography seem chiefly applicable to cases where the light employed is not that of the sun. The connection of optical telegraphy with electricity comes into existence only when the signals are given by means of the electric light. A fifth part, which the author calls the last, though a sixth follows, discusses the application of electric motors to automatic torpedoes, to submerged torpedo boats, and to military æronautics.

In the sixth part the author, quoting the saying, "there is nothing new save what has been forgotten," explains how vicious horses can be safely shod by dint of what may be called electric persuasion. The instrument employed is an "electric bit," very similar to that which has been invented in America for preventing accidents from runaway horses.

Colonel Gun explains his ideas well, and is evidently thoroughly master of his subject; but that subject is profoundly saddening.

Electricity, Experimental and Practical. By H. LEBLOND. Vol. I. *General Study of Electrical Phenomena and the Laws by which they are Governed.** Paris and Nancy: Berger-Levrault et Cie.

At the present day, if we take up a manual of any of the physical sciences published in England, we may feel sure that it will be written with reference to some examination. It would almost seem that French manuals are compiled with a view to a purpose not less

* Electricité expérimentale et pratique Etude Générale des phénomènes électriques et des lois qui les Régissent.

to be regretted, the art of war. The volume now before us belongs to the Naval Library, and is the reproduction of a course of lectures delivered to torpedoist officers. In his preface, M. Leblond remarks that "we find on board men-of-war electric bells, telephones, arrangements for the electric discharge of cannon or for illuminating their line of aim; the torpedo service requires an important electric material; all powerful men-of-war are at present lighted up internally by means of electricity, and the photo-electric machines employed to create for them on the outside an illuminated protective zone rank among the most powerful now in use. The total of the appliances embarked in one of our ironclads make up a very important electric installation.

The present volume is confined, however, to facts and to their laws, without entering upon their applications, constructive or destructive. It might, however, have been easily and advantageously made more comprehensive. Among the apparatus for the conversion of mechanical power into electricity, the only one described and figured—very badly—is Ramsden's plate machine. Indeed, the illustrations generally may be pronounced slovenly and inferior to a degree very unusual in French works. The machines of Holtz and Carré are merely named without any description. Neither do we find here any mention of secondary batteries; although possibly their description will follow in the second volume; nor does there here occur any mention of Ruhmkorff's coil and of the principles involved. The study of electric machines and of the electric light is reserved for the third and last volume.

The author seems to have conducted researches on the telluric currents as generated by the inductive action of the sun and the moon, or by the earth's displacement in the magnetic field of the heavens, and to have reached interesting results which may perhaps find application in meteorology. A good index would greatly enhance the value of the work.

ELECTRIC LIGHTING IN EDINBURGH.

ON Tuesday the question of electric lighting, brought before the Edinburgh Town Council some time ago, in connection with the Bills which private companies are to promote in Parliament next year, was under the consideration of the Lord Provost's Committee. It appears that some difficulty has arisen as to whether the Town Council or the Gas Commissioners are the "local authority" in a matter of this kind, and the difficulty is one which the Board of Trade share. In order, therefore, to have the point decided, it was arranged by the Committee to draw up a statement bearing on the question, which will be laid before the legal adviser of the Board of Trade. Thereafter, the whole matter will come up before the Town Council for consideration. The Edinburgh Gas Commissioners sat in private on Monday, to consider the following motion:—"That it be remitted to the Works Committee to consider and report as to what attitude the Commission should assume towards electric light companies proposing to supply electric light and power for the citizens of Edinburgh." Mr. Beveridge, Parliamentary agent, was present, and made a statement regarding the powers and duties conferred upon the local authorities under the Act of 1882, as to supplying electric lighting. He said he had been in consultation with the President of the Board of Trade and other authorities in London on the subject, but no definite conclusion had as yet been arrived at. The matter was then remitted, with powers to the Works Committee to watch and protect the interests of the Commission.

Telegraph Posts.—The Director-General of Stores for India, Whitehall, London, is prepared to receive tenders for the supply of component parts of telegraph posts. List closes 2 p.m. on 7th August.

SCOTCH GAS MANAGERS AND ELECTRIC LIGHTING.

IN opening the twenty-eighth annual general meeting of the North British Association of Gas Managers, held at Dunfermline on Thursday week, the Chairman (Mr. George H. Hislop, Paisley) said all the papers to be read dealt with matters connected with their every-day work and experience; but no reference was made to a new enterprise upon which many of them were destined very shortly to embark, as even now the characteristic "buzz" of the electric generator was loud in their ears, and to some it might sound like a war-cry or challenge to combat. The duty of every local authority (and, when failing, the gas company) was plain—viz., to supply both gas and electricity, as was now largely done in America. Meanwhile, and by way of addition to present professional skill, let every gas manager educate himself in the principles of electrical science, and thus fit himself for the exigencies of his position, and that without failing in energy and zeal in maintaining and demonstrating the superiority of coal and cannel gas for the purposes of light, heat, and power over all other rivals. No one could deny the advance which electric lighting had made within the last ten years; but they had got another rival in the field in the form of water gas. In his opinion this gas could not approach coal or cannel gas in value or efficiency.

NOTES.

Church Lighting.—It is intended to adopt the electric light in Strasburg Cathedral.

Telephony in Wurtemburg.—There are in Wurtemburg seven telephone systems, viz., those in Stuttgart and its suburbs, Heilbroun, Ulm, Reutlingen, Esslingen, Gmund and Ludwigsbury. There are 1,054 subscribers, 762 of whom are in Stuttgart.

The City Lighting.—A meeting of the City Commission of Sewers was held on Tuesday at Guildhall; Mr. G. Manners presiding. The Streets Committee, by Mr. F. F. Day, their chairman, brought up a report relative to the tenders for electric lighting in the City. They recommended that the tender of the Anglo-American Brush Company should be accepted for the Central District, the Metropolition Electric Lighting Company for the West, and the Electric Supply Association for the East. The annual cost of gas in the City was £5,500; that of the electric light would be £10,000. Two of the companies charged £26 per lamp per annum, and the third £24 odd, but the light in the latter case was to be extinguished at midnight. This the Committee declined to accede to and the subject would be further considered.

At the same meeting it was proposed by the chairman and a select committee that four contracts for lighting the city with electric light from four unknown companies should be accepted without being read. Such an extraordinary proposition naturally took the members of the Court by surprise, but Mr. George Rose-Innes vigorously attacked the proposal, and after a spirited contest, the matter was for a time shelved.

Electric Lighting of Port Louis (Mauritius).—Tenders are invited by the Municipality of Port Louis from persons prepared to undertake the lighting of the city by gas or electricity. A copy of the specification is deposited at the National Provincial Bank of England, 112, Bishopsgate Street, London, and with Mons. L. G. Adam, agent-general for the Corporation of Port Louis, 134, Boulevard Haussmann, Paris, of whom also forms of tender may be obtained. Tenders are to be made 15 days before the departure of the mail which leaves Marseilles on the 1st October.

Davey, Paxman and Company.—A revised edition of their illustrated catalogue has just been issued by Messrs. Davey, Paxman & Co., of Colchester. They point out that their large experience as manufacturers of engines and boilers for electric light installations enables them to give intending purchasers the best advice as to which sizes and types of engines and boilers to adopt to ensure the maximum of efficiency and economy in each particular case. The record of successes, where the engines made by this firm have been tried in competition with others, is certainly one to be proud of. In 1887, at the Royal Agricultural Society's Show at Newcastle, they obtained the only two prizes offered—namely, £200 for the best compound portable engine and £100 for the best single cylinder portable engine; and in the following year, after exhaustive trials by the Society of Arts, Messrs. Davey, Paxman & Co. were awarded the only gold medal for steam engines and boilers. Much of the success of the electric lighting of the series of exhibitions at South Kensington was due to the steady running of the machinery, and in no single instance was there any failure on the part of the engines. Illustrations are given of the electric lighting shed at the Colonial and Indian Exhibition, of a group of compound condensing steam engines with air compressors, erected by the firm at St. Fargeau, Paris, for distributing air through the streets of Paris for driving prime movers, and of a battery of "Economic" safety boilers made and erected by the firm for supplying steam to the engines last mentioned. A prominent position is occupied by this firm at the present Paris Exhibition, the whole of the motive power required in the British section being supplied by them, as well as 700 horse-power for driving the electric light machinery. In the catalogue will be found full descriptive particulars of the engines specially designed and adapted for electric lighting purposes, and any one likely to become a purchaser of engines or boilers should not fail to obtain a copy.

Lock and Block Systems.—Messrs. Saxby and Farmer have sent us a copy of their new edition of "Railway Safety Appliances," which consists of illustrations and descriptions of their latest forms of apparatus for securing the safety of railway travellers. The administrators of the great railway systems are unanimous in acknowledging that by the adoption of the lock and block system and the continuous brake preventible accidents have been reduced to a minimum, the immunity where these precautions are adopted being simply marvellous. Full particulars are given in this publication of the system invented by Messrs. Saxby and Farmer for uniting the working of the block and interlocking systems, making them inter-dependent, and so securing the absolutely correct working of the out-door signals.

Telephony in Bale.—Sissach has been connected with the Bale and Liesthal telephone system. The number of public call offices remains stationary, namely, eight, but the total of individual subscribers is constantly increasing, 84 having joined in the last eight months. The figures are as follows:—

December	1885	551	apparatus.
June	1886	600	„
December	1886	657	„
June	1887	718	„
December	1887	777	„
June	1888	837	„
September	1888	869	„
May	1889	953	„

Re **Chas. Baker & Company's Advertisement.**—The Gwynne-Pilsen Electric Company, *per* W. H. Trentham, writes to us as follows:—"We observe in your issue of last week you express surprise that Messrs. Chas. Baker & Co. advertise for tenders for electric lighting. We shall be much obliged if you will kindly state that we need no assistance in carrying out our contracts; we are quite prepared to go on with the lighting, carried on for years past, on the basis of our contracts."

A Far-Seeing Individual.—It is announced that M. Courton, a chemist, produced recently at the sitting of the French Academy of Sciences a sealed envelope containing a description of an apparatus by means of which objects may be seen at vast distances, the vibrations of light being transmitted through a wire.

Electricity in Mines.—The cattle show of the Lancashire Agricultural Society was held during this week at Wigan, and Messrs. Walker and Oliver availed themselves of the opportunity thus afforded of introducing to the notice of the colliery owners of the district some of the applications of electricity to mining work. Working models were shown illustrating methods of electric signalling, and a number of incandescent lamps were run by a dynamo driven by a Marshall engine. An electric motor was also exhibited, driving a model fan made by a local firm of mining engineers. The display also included a variety of switches, brackets, weather-proof protectors, and other items specially adapted to mining requirements.

Electric Lighting at Southsea.—With the view of providing an extra attraction for the thousands of visitors who have this week been pouring into Portsmouth for the Naval Review, the Corporation decided to light the fine esplanade facing the sea with the electric light. On Thursday evening of last week the experiment was made for the first time, the entire promenade, extending over a mile from pier to pier, being illuminated with 24 2,000 candle-power arc lamps. The system employed is the Thomson-Houston. The work is being carried out, under orders of the Corporation, by the Laing, Wharton and Down syndicate, who are under an agreement to light the esplanade from August 1st to 8th. The system has been in use for the last five or six weeks in lighting the Esplanade Hotel with great success, and should the result of the present trial be as successful as is confidently anticipated, a distinct advance will have been made in recommending the electric light to the people of Portsmouth.

Irish.—The Belfast *News Letter* of the 29th ult. commences a leading article thus:—"In view of the probable development of electric lighting by means of the forthcoming Electrical Exhibition in London . . ." Surely our contemporary intended to say Birmingham, or failing that, Edinburgh!

The Edinburgh Electrical Engineering Exhibition.—The guarantee fund of the Edinburgh Electrical Engineering Exhibition, which was only opened on Friday last, has made very satisfactory progress. In addition to the sum of £1,000 promised by the Corporation of Edinburgh, several sums of £500, and numerous sums of £100 and £50, have been subscribed by firms and private individuals. The site of Meggatland, consisting of about 40 acres, has been definitely settled upon. The Exhibition will partake of a more general nature than was first intended; but electrical engineering, together with the subject of inventions and general industries, will form special features.

Okonite.—The *Electrical World* says:—"Captain Candee, Treasurer of the Okonite Company, has returned to New York from his European trip. He succeeded in making a contract with the City of Paris for 8,000 feet of okonite telephone and telegraph wire. Captain Candee examined many important locations in England, with a view of establishing a manufactory there to supply the steadily increasing European demand for okonite wire and cables.

Personal.—In consequence of ill-health, Prof. Jas. Thomson, Professor of Civil Engineering and Mechanics in the Glasgow University, has tendered its resignation.

The Erection of Wires at Exeter.—The Exeter Electric Lighting Company has commenced the erection of supports to carry the wires through the streets.

Damage to Insulators. — In a recent action at Leeds by the postal authorities against some lads who were convicted of throwing stones at the porcelain insulators attached to the telegraph posts in Gelderd Road, it was stated that no fewer than 530 insulators had been maliciously broken on this line since June, 1887. It seems to point out an incidental advantage in length of life for insulators of a more unobtrusive colour than white porcelain.—*Mechanical World.*

Electricity in Brussels.—The tenders invited for the supply of the electric light to the town and to private consumers have been opened. Six offers were received. The firms tendering were l'Electrique, of Brussels; the Compagnie Internationale d'Electricité, of Liège; the Telephongesellschaft, of Zürich; M. van Rysselberghe; the Thomson-Houston Company; and Messrs. Siemens and Halske, of Berlin. The tenders have been taken into consideration, and will be reported upon by the Municipal College.

The Government Telegraph Service.—A Manchester paper says:—"One of the most popular branches of employment afforded by the Government is that of the telegraph service. In recent years this department has increased in prosperity by "leaps and bounds," and its attractions are of such a nature as to lead to great competition. As an instance of the popularity of the service, I may mention that an examination held a few days ago in London led to a competition of the most severe character. For 15 male clerkships there were between 3,400 and 3,500 candidates.

Military Telegraphy Experiments in France.—At the next manœuvres experiments in a new application of telegraphy are to be made. By the aid of a rather complicated apparatus, the manipulation of which, however, is not difficult, efforts will be made to reproduce at a great distance a drawing, a plan, or a map. If the system be sufficiently practical, endeavours will be made to adapt it easily to field telegraphs. According to French authorities, this innovation would be of great service in time of war.

Annual Excursions. — The staff of the General Electric Company, Limited, together with a few invited guests, making a total of 40, had their third annual outing on Saturday last. The party went by rail to Windsor, embarked on the steam launch *Lottie*, and landed again at Monkey Island, where an excellent dinner was served. During the afternoon sports of various kinds were indulged in on land and water. Queen's weather favoured the entire proceedings, which were of the happiest possible kind, good music forming part of the day's pleasure. Several appropriate speeches were delivered after dinner, in one of which it was announced by Mr. G. Binswanger that his firm had recently been converted into a limited company, himself and a few intimate friends being the principal shareholders; this was done in consequence of the rapid growth of their business. Mr. Hirst, the manager of the electric light department of this company, received the highest praise for the manner in which he arranged the excursion, and he fully deserved the eulogium.

The Edison & Swan Company's workpeople held their annual excursion on Saturday, 20th July, at Yarmouth, A very pleasant day was spent, the weather being exceptionally fine. Dinner was served to a large company in the Aquarium, after which several toasts were given and heartily drunk. The success of the company was given by Mr. D. Hutt, coupled with the name of the respected resident superintendent of the factory, Mr. Gimingham. Mr. Robson (works' foreman), in the regretted absence of Mr. Gimingham, briefly replied. Other toasts followed. Regarded from any standpoint the affair was eminently successful, and credit due to the manner in which the arrangements had been carried out by the workmen's committee.

The Public Safety Signal.—The *Times* states that under this name a system of police signals and alarms has been introduced into this country from the United States, where it is in operation, and has been working for some six months past in Islington in connection with the Upper Street Police-station. The system consists of numbered signal boxes, which are affixed to a wall, and are placed at convenient distances from each other on every police beat. Each box contains telephones and automatic signalling instruments, and is electrically connected with the police-station. Each policeman is provided with a key which opens the box, and with two special signalling keys, with which he can automatically transmit messages by inserting them in apertures without opening the box. From any box a policeman can send a request to the station-house for aid, or for an ambulance in cases of accident. He can also converse with his officers at the station by means of the telephone. In emergencies, however, the chief dependence is placed on the automatic signals, which are quicker and surer than telephonic messages. Each police-station is provided with an ink-registering instrument, which automatically records the messages sent from the street boxes. Attention is called between the station and the boxes, or *vice versâ*, by electric bells. Automatic signalling from the outside of the box can also be carried on by any householder who may be provided with a special key, and which bears a number referring to his name and address. This key, however, when inserted, is retained in the keyhole until released by a policeman, so that if unnecessarily or wantonly used the offender is detected.

On Tuesday, in the House of Commons, Sir Albert Rollit put the following question to the Home Secretary:—"Whether, having regard to the satisfactory results of the electric police-signal system which has been in operation in Islington, the Government propose to take steps with a view to its general adoption." Mr. Matthews replied that the question of the adoption of the Islington system of electric police signals was under his consideration. He was making enquiries as to the probable cost of any practicable scheme, but he could not yet say definitely whether the system was one that could be used with advantage, either generally throughout the metropolis, or in particular districts, and elsewhere throughout the country.

A Provisional Order Abandoned.—The Metropolitan Electric Supply Company has definitely abandoned the provisional order granted by the Board of Trade for the electric lighting of South London, under which it was empowered to supply with electric light the parishes of Lambeth, Streatham, and Clapham.

Electrical Treatment of Sewage.—Mr. Wm. Webster has been in negotiations with the Maidstone authorities with a view to carrying out some extensive experiments with his electrical process for the treatment of the sewage at Maidstone. He proposes to carry out the experiments at a cost of £200, such sum to be paid by the town if the experiments are successful; but if not successful, he will bear the cost himself. If Mr. Webster's process proves satisfactory, he will then undertake to purify the sewage on an agreed sum per annum. The Local Board has agreed to fall in with Mr. Webster's proposals, and as the Local Government Board is applying pressure for some steps to be taken to prevent the river Medway from being polluted by the discharge from the town sewer, the work will be commenced without delay. The question of how to effectually deal with this sort of nuisance is arising throughout the country, and the experiments will be watched with intense interest by all public bodies.

Overhead Wires.—A letter has been addressed to Mr. Courtenay Boyle, of the Board of Trade, by the London Chamber of Commerce, asking for certain modifications in the regulations which have received the careful attention of a special committee. It is not considered necessary to trouble the President with a deputation,

A General Re-christening.—We have received a copy of the following circular, signed "G. Binswanger and Co.":—"We have pleasure in informing you that we have registered as a limited liability company the business which we have carried on in London and Manchester under the styles of the General Electric Company (G. Binswanger & Co.), London, and The Manchester Electric Works Company, Manchester. The name of the new company is 'The General Electric Company, Limited,' of London and Manchester (G. Binswanger managing director). Head office, 71, Queen Victoria Street, London, E.C. Works: Chapel Street, Salford, Manchester. The company will continue to be a private concern, our object having been to enable us to cope with the increasing demand for our manufactures. The management remains unaltered, as Mr. G. Binswanger is managing director, supported by two co-directors, Mr. Max Binswanger and Mr. H. Hirst, both of whom have for many years been at the head of our electric bell and lighting departments." We understand that the change is made solely with the object of defining the capital of the present partners, and that there will be no public issue of shares. This business has made remarkable progress during the past few years, and we hope that in the future even the rapid development of the past may be exceeded.

The Bays Cell.—In our notice of Mr. Bays's cells we stated that they were sealed with the usual asphalt compound. This, we are informed, is not so; after many experiments, the inventor adopted a special method of preparing the porous pot and sealing, which effectually prevents creeping, while, if they are sealed in the same way as the Leclanché, it causes great trouble. We omitted, also, to mention that the cell is patented.

Hotel Lighting.—The Savoy Hotel, on the Thames Embankment, which is to be opened on Tuesday next, is to be lighted throughout by electricity. It is scarcely likely that any first-class hotels to be erected in the future will dispense with the electric light.

Gas Companies Supplying Electricity.—The secretary of the Falmouth Gas Company has written to the Penryn Town Council stating that it was the intention of his directors to make application under the Electric Lighting Acts for the supply of electricity within the area of the Borough of Penryn.

The Electric Light in Formosa.—A consular report says that the new city of T'ai-pei Fu, the present capital of the island, is now lighted electrically. The plant is under the charge of native workmen. China seems to be more progressive than London has been.

Telephone Tickets.—The Southern New England Telephone Company, of America, is about to issue tickets for the use of those who are not subscribers to the exchange of the company. The company has found that there are a good many people to whom the occasional use of the telephone is a great convenience, for which they are willing to pay a small fee. Now the only way that they can avail themselves of the convenience of the service is to ask the use of their neighbour's instruments, thus bothering the neighbour, and taking from the company that for which they do not pay. The tickets allow the holder one local communication from any subscriber's station where the subscriber is willing to let the instrument be used. The tickets will cost 10 c. each in strips of five, and where the holder of the ticket uses an instrument, he will leave a ticket with the subscriber whose instrument he uses. This ticket the company will redeem as 5 c. cash in the settlement of its bills with the subscriber. Thus the company receives a small fee for the service that it renders, and the subscriber receives a small compensation for the accommodation that his instrument has been to the user of the ticket.

Telephone Extension at Southampton.—An exchange will be shortly opened by the Western Counties and South Wales Telephone Company on the Hants County Cricket Ground at Southampton, by means of which the score may be ascertained at any time by all subscribers to the system. In order to simplify the work of the operators it is intended to employ at the Southampton central office a new multiple switchboard, similar to that in use at Bournemouth and Portsmouth. It is expected that by the end of August the connection between Portsmouth and Bournemouth, through Southampton, will be complete. Mr. Robinson, the company's superintendent at Southampton, is making active preparations for the progress of the work.

NEW COMPANIES REGISTERED.

General Electric Company, Limited. — Capital £60,000, divided into 7,000 first preference shares, 1,000 second preference shares, and 4,000 ordinary shares of £5 each. Objects: To take over the business of the General Electric Company, of 71, Queen Victoria Street, and 22, 23, 24, Garlick Hill, E.C., and of 71 and 73, Bentham Road, South Hackney; also the business carried on in Clegg's Court, Chapel Street, Salford, Lancaster, under style of the Manchester Electric Works Company, with the goodwill, patents and other assets of such business. The signatories (who subscribe for first preference shares) are as follows: *Gustav Binswanger, 71, Queen Victoria Street, 2,000 shares; J. H. Ward, 22, Lower Phillimore Place, Kensington, 3,000 shares; *H. Hirst, 71, Queen Victoria Street,; S. Smith, 157, Milkwood Road, Herne Hill; G. S. Joseph, 165, Fenchurch Street; A. R. Bernhard, Hillbrow, East Finchley; Hy. Heritage, 7, Wendover Road, Harlesden, one share each. The signatories denoted by an asterisk and Mr. Max Binswanger are appointed directors. Two directors are also to be appointed by Mr. J. H. Ward, and these will be removable from office by vote of the holders of the first preference shares; their remuneration is to be £210 in each year in which 10 per cent. dividend is paid on the first and second preference shares. The services of Max Binswanger and Hugo Hirst are gratuitous. Mr. Gustav Binswanger is appointed managing director at a salary mentioned in an agreement with the company. Registered office, 71, Queen Victoria Street.

Thomas Lighting Company, Limited. — Capital, £15,000 in £10 shares. Objects: To acquire several letters patent granted to Thomas Cooper John Thomas, of 5, Carlton Road, Finsbury Park, for improvements in gas lamps, and all patents to be hereafter granted to Mr. Thomas relative to lamps for oil, gas, or for electric lighting purposes. Signatories: A. Adams, 101, Adelaide Road, N.W.; J. Bell Sanderson, C.E., 30, Pandora Road, N.W., 50 shares each; F. Dagley, 101, Adelaide Road, N.W.; Mrs. A. Adams, 101, Adelaide Road; T. C. J. Thomas and Mrs. Thomas, 5, Carlton Road, N.W.; E. C. Steavenson, 93, Gracechurch Street, 1 share each. Registered 29th ult. without articles, by Steavenson and Cauldwell, 93, Gracechurch Street.

D. Hulett and Company, Limited —Capital, £35,000 in £5 shares. Objects: To carry on business as manufacturers of lamps, apparatus, machines, &c., for the utilisation, purification, consumption, supply, storage, generation and distribution of gas, mineral, or other oils, and electricity or other power or element. To carry on business as mechanical, electrical, and hydraulic engineers and manufacturing chemists. To take over as a going concern the business of D. Hulett and Co., of 55 and 56, High Holborn. Signatories (with 1 share each): W. H. Richardson, City Glass Works, Glasgow; H. C. Pond, Avenue Road, Stamford Hill; Robt. King, C.E., Eltham; A. Durdin, 35, Falkland Road, N.W.; J. Huskisson, 69, Westfield Road, Hornsey; G. W. Cooper, 58B, Farringdon Road

Buildings; H. W. Whitcomb, 46, Cranmer Road, Brixton. The signatories are to nominate the first directors; qualification, £500 in shares or stock. The company in general meeting will appoint remuneration. Registered 30th July by Wm. Foster, 7, Queen Street Place, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Westinghouse Electric Company, Limited.—Upon terms of an agreement with the company of the same name, incorporated in accordance with the law of Pennsylvania, U.S.A., this company will purchase the business of the American Company other than that carried on in North and South America. The sale includes the contracts entered into with the Metropolitan Electric Supply Company, Limited, for the erection of machinery at their station in Sardinia Street. The purchase consideration is £488,000, papable by the issue of 30,000 ordinary shares of £10 each, and 18,800 preference shares of £10 each, to be issued as fully paid up. The registered office of the company is situate at 105, Gresham House, Old Broad Street.

United Telephone Company, Limited.—On July 26th this company filed with its registered documents of the company, the special resolutions passed on June 4th and confirmed July 4th, authorising amalgamation with the National Telephone Company, Limited.

National Telephone Company, Limited.—On the 26th July this company filed the special resolutions passed on the 4th June, and confirmed 4th July, relating to the taking over of the business of the United Telephone Company, Limited, and the Lancashire and Cheshire Telephonic Exchange Company, Limited. The new articles of association were filed on the same day authorising a capital of £4,000,000 divided into 15,000 first preference shares of £10 each, 15,000 second preference shares of £10 each, and 74,000 ordinary shares of £5 each. The directors are Charles S. Agnew, J. W. Batten, James Brand, J. Bruce, J. S. Forbes, Peter Garnett, Eli Heyworth, Col. R. Raynsford Jackson, F. R. Leyland, J. Bond Morgan, Dillwyn Parish, W. Cuthbert Quilter, M.P., G. H. Robertson, S. H. Sands, Alderman Joseph Thompson. Qualification, £3,000 in shares; remuneration, £5,000 per annum, to be divided as they may determine.

Lancashire and Cheshire Telephonic Exchange Company, Limited.—On the 26th July a notice was filed of the special resolutions passed on the 11th June, and confirmed on the 4th July, authorising the amalgamation of this company with the National Telephone Company, Limited.

Dutton & Company, Limited (Mechanical and Electrical Engineers).—An agreement of 30th June, filed on the 19th July, provides for the purchase by the company of the business of Dutton & Co., of Worcester, railway signal engineers and manufacturers. The purchase consideration is the allotment of 1,825 ordinary shares to Mr. S. T. Dutton and to Mr. S. G. Corkran, 575 ordinary shares, to be issued as fully paid up; a further part of the consideration is £1,000 in cash. The stock-in-trade and machinery will be purchased at the valuation price of £1,950, payable in cash.

THE BIRMINGHAM EXHIBITION.

THE Electrical Exhibition, opened yesterday at Birmingham, bids fair to prove one of considerable interest to manufacturers from the surrounding districts, and also to the general public of the locality. Messrs. Fowler, Lancaster & Co., the initiators, promoters and engineers of the undertaking, certainly engaged themselves in no slight task, seeing that Bingley Hall was handed over to them but three weeks ago. Since then much has been done, but a great deal remains to be done to achieve that completeness which the above energetic firm has set itself to accomplish.

At the opening ceremony Mr. Joseph Ansell, the deputy Mayor of Sutton Coldfield, having sketched the history of Birmingham exhibitions, beginning with that held long before the Great Exhibition of 1851, in London, which he claimed was suggested by that of an earlier date in the Warwickshire town, Lady Randolph Churchill, who was accompanied by her husband, in a few and appropriate words, declared the Exhibition open to the public.

Up to the time of opening some goods were still unpacked, others were unplaced, and some, but fortunately few, exhibits had not yet arrived. Among the former may be mentioned with regret, the cars for the telpher line running round the gallery in the gardens.

The lighting of the Exhibition building has been entrusted to the Anglo-American Brush Company, Messrs. Ernest Scott & Co., Laing, Wharton & Down (Thomson-Houston system), Elwell-Parker, Limited, Planet Electrical Engineering Company, Mr. Goldston (Bernstein system), and to Messrs. Shippey Brothers (Waterhouse system). The last mentioned firm has, we understand, been unable to carry out its portion of the work owing to patent complications with the Westinghouse Company.

The supply of electric motors for driving working exhibits is undertaken by Messrs. Crompton & Co., Immisch & Co., Laurence, Paris & Scott, and Elwell-Parker, Limited. Among the engines for supply of motive power will be found a high-speed Armington and Sims engine of 80 H.P., exhibited by Messrs. Greenwood and Batley; a compound engine of 80 H.P. by Messrs. Ruston and Proctor; a compound engine of 30 H.P. by Messrs. Robey & Co., who likewise exhibit two high-speed engines of their latest pattern, one of which is also compound; also a vertical Raworth engine is exhibited by the Anglo-American Brush Company. The boilers for supplying the steam to these engines are two by Messrs. Galloway, of Manchester, capable of working up to 300 H.P. at a pressure of 100 lbs.

The two large Robey and Ruston and Proctor engines drive the main countershafting, which is fitted with Wells's wrought iron split pulleys and flexible bearings.

Electrical conductors are well represented by Messrs. W. T. Glover & Co. (an extensive and well arranged assortment of specimens); W. T. Henley and Company, Limited; Callender Bitumen Company, Limited; and by Messrs. John Fowler and Company, Limited, who exhibit the well known Tatham lead-covered cables.

The Edison and Swan Company has a large case of incandescent lamps, &c., and the Electrical Power Storage Company likewise has a stand, on which various samples of its accumulators are displayed.

In the list of exhibitors may also be found the well known names of the following electrical firms:—The Acme Electric Works; Messrs. Appleton, Burbey and Williamson; Buller, Jobson and Company; J. Davis and Son; Fowler, Lancaster and Company; General Electric Company; Lacombe and Company; Mayfield and Company; Muller and Company (Schuckert instruments); Nalder Brothers; the National Telephone Company; Julius Sax; the Schanschieff Battery Company; J. G. Statter and Company, Limited; Stafford and Eaves.

Sir David Salomons also has an exhibit of a "complete set of apparatus for rendering an installation, containing an accumulator, completely automatic, also self-governing in respect to keeping the charging current constant and the pressure on the lamps constant by counter E.M.F." The arrangement is Sir David Salomons's own, and is that which he has worked satisfactorily for many years at his home at Broomhill. Gas engines are exhibited by Messrs. Dick Kerr & Co., by S. B. Barker & Co., and by Messrs. Crossley Brothers.

From the foregoing it will be seen that although there may be to the initiated but little of exceptional novelty, there must be in this very considerable collection of apparatus and machiney much of an interesting nature, and much also to demonstrate the progress made since the last successful exhibition of a similar kind held in Birmingham about three years ago. The representative character of the exhibition, coupled with the central position of the town, should induce all interested in the progress of the electrical industry to pay the Midland town an early visit.

CITY NOTES, REPORTS, MEETINGS, &c.

Edison and Swan United Electric Light Company.

THE sixth annual general meeting of the shareholders was held last Tuesday at Cannon Street Hotel, Mr. Staates Forbes occupied the chair.

After the Secretary had read the notice,

The Chairman said: I should feel much more at home if we had a larger audience. The report has been printed and circulated, and, in accordance with practice, I shall proceed to make a few remarks, and to give such elucidation to the figures as you may desire, and then propose certain resolutions. Perhaps I had better go at once into the figures; having dealt with them I shall have to say a few words on the general subject of the position of the company. The

balance sheet I think we had better deal with first, and I shall very shortly deal with it. On the debtor side, which statement of capital remains unaltered during the year, there has been no addition to capital. It is set forth in the simplest possible form, and you will see how it is made up. Putting the different sums together of fully paid shares and partially paid shares the A capital comes to £353,478. That is the particular capital which, being encumbered with no prior shares, comes in for the first fruits of the undertaking; after that there are so many shares amounting to £117,820, the shares which are in fact held by Mr. Edison and his friends, and which stand in the position of the deferred after the cumulative dividend on the A shares. Sundry credited balances, £4,711, being in fact money to which we are indebted to outsiders, and about that I have to say it is more favourable than it was last year, when it stood at £10,214. Well, then, the last item is not the least satisfactory one, profit and loss, as per appropriation, £14,000 against £25,000 in round numbers last year. On the other side of the account you will see the cost of patents, goodwill, preliminary outlay, and loss on working, as per last balance sheet, £274,991. During the year we have spent upon it £13,999. In addition we have realised by sale of plant, and other sums which we are to receive, £12,560; then we have to deduct shares to the amount of £12,000 held in the Manchester Company. The further deduction losses on realisation of sundry installations taken over at the date of amalgamation and heretofore reckoned among the capital outlay. The directors have from time to time explained the nature of this business taken, and our business has been to eliminate the bad from the good and to charge to the working of the undertaking, as opportunity offered, losses which were involved in getting rid of these bad bargains. I am glad to say we have now written down this last. I should like you just to realise this asset cost of patents, preliminary outlay, &c., is rather in the nature of something in the air, in the sense of not being a tangible thing which you could sell, such as tables, chairs, or anything of that sort, and it is very different from the items that you find set out below, which are concrete things, such as the Manchester, Edison and Swan Company investment. It strikes me as being a satisfactory thing that the result of the work of the year has enabled us to reduce what I may call the dead asset, and very considerably adding to the living asset. If you call a living asset the £12,000 in the Manchester, Edison and Swan Company it is not a particularly productive asset at the present moment, because it stands in the same category as the shares to Mr. Edison, £117,000. It is addition to the capital provided by the Manchester Company. Electric lighting businesses is showing signs of improvement, and that which was not a very promising asset may in the future be a very valuable one. I think our own shareholders will see that in two or three years the position will be greatly changed. Investments, £27,590; this is well invested capital. Freehold property, £27,991; that covers possession of the land and factory where we now manufacture the bulk of our lamps at Ponder's End, the site in London called the Green Street site, which is put down within its original value, also a remnant of property at Newcastle. Plant and stock, £40,406. Of course, our factories are fitted up with plant and stock, and we have from year to year a great deal of tangible concrete value in that form. Of course, the value of such things depends upon their being part of the going concern. If one had to anticipate the possibility of the business stopping and those appliances being thrown out of gear they might not be worth 20s. in the £.; but as parts of a going concern producing profit they are certainly not over-estimated at that price. The item of office furniture was very small, and was being written down year by year, and I daresay the time is not very distant when we shall have redeemed all our furniture. The debtor's amount is £29,221, and we believe all good debts; then there is cash at the banker's, £29,206. Compared with the corresponding valuations and money in hand last year, that item is increased. It stood last year at £125,800; it is now £166,610, and is therefore about £41,000 to the good. I think we may congratulate ourselves on the result of the balance sheet. We now come to the profit and loss account—that, in fact, is the trade account; there, again, we can congratulate you upon the realisation of what has been predicted from time to time—that the business only wanted time to develop, and to develop rapidly, which it has done during the past year. In the preceding year we showed a not inconsiderable advantage, having realised about £25,000. For reasons which were explained at the time, and which the judgment of the proprietors commend, it was not distributed. As compared with that figure, this year the profit is much larger. The stock on hand, which means lamps and the materials connected with the manufacture of lamps as distinguished from the value of plant in the factory, is £19,590. The wages, purchase cost of installations, stands at £62,529; salaries, directors' fees, office expenses, at £8,562. Then there is the small item of a special character which will disappear from the accounts in the future, Mr. Swan's particular bargain with the company having terminated. The next item is depreciation of plant, £1,394, which we have written down in order to keep well within the value. The reserve for Manchester Edison and Swan is the next. This is a small amount for damages which we have received. Then there is the income tax. On the other side of the account sale of lamps, fittings, and charges for work done, £111,715, interest, £1,000; Messrs. Davidson and others £2,140. This is rather an accidental item of damages or results of litigation paid by gentlemen who, having infringed our lamps and being found guilty, had to pay the penalty in royalties on the lamps they had sold. Then the stock on June 30th, 1889, was £25,985, and that you will see is somewhat increased. We began the year with £19,500, and have now £6,000 more. The stock of lamps must, of course, increase from year to year, because it has to bear a proportionate relation to the volume of our business. The value of the business this year is £112,763; last year it was £88,404, therefore the results have increased by £24,000. That is a very gratifying feature. Our business is of a character which involves, compared with other businesses, very large sums for fixed charges; whether you produce a large stock or a small stock of lamps, you have the same amount to pay for rents, salaries, and such like. I will take you now to the paragraphs of the report; it shows how we have dealt with the balance of £72,000. We were face to face for the first time with the distribution of a dividend, and a distribution of a dividend in joint stock companies is not without its thorny places, as far as the responsibility of the directors goes. We were like other trustees, obliged to consider what the ultimate consequence of our action would be in dealing with the trusts, and there has been so much litigation and so much partially made law as to what is capital and what is profit, that we have been obliged to be very particular in the consideration of this matter. Of course it is more or less abstract, for there is really no settled law upon which directors could act, and we were in the unfortunate position of having to determine what ought to be done in justice to the shareholders and for our own protection as trustees. Well, we have thought it judicious to write down everything in the nature of a loss which has accrued since this business was initiated. We went into it with our eyes open, and we knew there were bad bargains, and the sooner we got out of them the better. Considerable sums have been written down in virtue of these losses in the earlier years of 1885 and 1886. We had indeed certain of these losses, and in the balance sheets they were dealt with by remaining as part of the goodwill, cost of patents, preliminary outlay, &c. We have now eliminated everyone of these things by appropriating £28,815 14s. 2d., which, as far as we can estimate at present, is the last item which is likely to trouble you under the head of loss. To meet this loss in conformity with the discretion invested in the board, we have done what is exceedingly prudent as men of business, and which will meet with the approbation of the shareholders. We have done it this year because we can afford it. We have also created a reserve of £4,595, and recommend the appropriation for dividend of 7 per cent. upon the amount paid up on the A shares in respect of the year ending June 30th, 1889, and of 3 per cent. further on account of the arrears of preferential dividend on the A shares in respect of the year ending June 30th, 1884. That dividend was not, therefore, resting on the profits of that particular year, but was an accumulated dividend. Therefore, where in any year the profits were not sufficient to pay 7 per cent., the balance became a charge on the extra profits of future years, and if you are familiar with the old report you will remember it was continually brought to your knowledge that the B shares were entitled to a quarter of the profits after 7 per cent. was paid on the A shares of the accumulated preferential dividend. After having paid the 7 per cent. there is still enough left to wipe out some of the arrears of accumulation, and upon that we propose to add a further 3 per cent. on account of the accumulated preferential dividend in respect of the A shares for the year ending June 30th, 1884, so that the dividend is 10 per cent. But what we want to impress upon you is, that you are not entitled to receive more than 7 per cent. in any particular year, but that 3 per cent. is coming back into your pockets to pay up old scores. I must qualify what I say, for if the arrears are wiped out and the business progresses in anything like its present ratio, next year the 3 per cent. will be larger. The A shares took the first fruits, and over 7 per cent. they participated with the B shares. Everyone knows that during the past few years we have gone through a great deal of trouble. We have had to guard our inventions, and have fought out the Woodhouse and Rawson Company and the Brush Company with the results already known. In concluding, he referred to the directors fees, which had appeared for the first time. When the company was poor they had accepted half fees, but now they were becoming rich he thought they were entitled to them.

The motion for the adoption of the report was then proposed, and seconded by Mr. F. R. Leylands.

A vote of thanks to the Chairman concluded the meeting.

The Globe Telegraph and Trust Company, Limited.

IN the report presented at the sixteenth ordinary general meeting, July, 1889, the directors state that the net revenue of the company for the year, after deduction of expenses, amounts to £188,624 1s. 2d., which, with the balance of £2,107 1s. 3d. brought forward, make a total of £190,731 2s. 5d. From this amount there has been distributed the sum of £126,300 15s. 2d. in interim dividends, leaving an available balance of £64,430 7s. 3d.

The directors recommend the payment of a final dividend for the year of 3s. per share on the preference shares, and of 4s. per share on the ordinary shares, making, with the former distributions, a total dividend for the year of 6 per cent., less income tax, upon the preference, and 4½ per cent. net upon the ordinary shares (against 3½ per cent. for the preceding year), and carrying forward a balance of £2,053 16s. 5d.

As indicated in the last report, the Imperial German Government have acquired the lines of the German Union Telegraph Company of Berlin, and that company, and also the German Union Telegraph and Trust Company, Limited, have been liqui-

dated. This company has received its proportion of the return of capital.

In addition:—400 shares of French Telegraph Company Paris to New York have been sold, and 66 shares of the German Norwegian Cable Company have been drawn for amortization, and paid off at par, less exchange.

The following re-investments have been made, viz.:—7,444 Eastern Telegraph Company's new shares. £62,000 Direct Telegraph 6 per cent. debentures. 2,700 West Coast of America telegraph shares (fully paid). 2,750 American Telegraph Cable Company's ($100 fully paid) shares. Five per cent. guarantee of the Western Union Company of New York. 3,145 West African Telegraph Company's shares, £10 fully paid.

The income from the re-investments will, it is anticipated, show an improvement on the securities paid off.

In conformity with the articles of association, Sir John Pender, K.C.M.G., and Sir James Anderson, two of the directors, retire, but, being eligible, offer themselves for re-election.

The auditors, Mr. John George Griffiths, F.C.A. (Messrs. Deloitte, Dever, Griffiths & Co.), and Mr. William Griffith, B.A., barrister-at-law, also retire at the meeting, and offer themselves for re-election.

The meeting was held on Tuesday last at Winchester House, Sir John Pender in the chair.

The Secretary read the notice and the minutes of the last meeting.

The Chairman said: Gentlemen, before I begin to make any remarks I must refer to the absence of one of our directors, Sir Daniel Gooch, who has always taken great interest in the working of the company. He has been ill for some time past, but his son, who is also on the board, informs me that he is getting well again, and I hope we shall soon see him amongst us. When I addressed you last, 12 months ago, I spoke with considerable hope; I referred to the previous year, when I spoke with doubt. Our surroundings were then dark, and the different telegraph companies were passing through a considerable state of excitement. The Anglo, which is one of our largest constituents, was fighting the question of the 6d. tariffs. Of course, the 6d. tariffs meant very much lower returns for the Globe Company. I am happy to say that, as I prophecied, I am able to give a better report on the affairs. As you know, we depend entirely for our dividends on these large companies, and I think they are doing very satisfactorily indeed. There is another important point that we are bringing before you to-day—that is, we have changed a considerable investment which we had in the German Submarine Telegraph Company, it having been bought by the Government of Germany, and have invested elsewhere, and, on the whole, we shall get a larger return for the re-investment than we had upon the German investment. These are all favourable points, but the most important of all is that the Anglo-American is now earning a fair dividend. The 1s. tariff has so far satisfied the requirements of the public, and we are getting now just double the amount of money we got previously. The Eastern Extension have also increased bonuses, and that has added very considerably to our income. We are paying a dividend of 1 per cent. higher than we paid last year, and we are also carrying forward a fair sum; we never intend to carry a large sum forward, only a moderate sum. Looking all round at our investments, I doubt if they have ever been in a more satisfactory state than at the present time. The 1s. tariff of the Anglo has been in existence 10 months, so that when we meet you again it will have had a good trial. I have given you a general detail of what has been done, and our company is to be the pioneer of those companies that have been formed of late years to break up and divide dividends. Our company was established years ago on the principle of preferred and deferred shares. Looking at the rise that has taken place, we may have considerable hope that that prosperity will continue, and that the deferred shares of this company will take up the position which I think they are entitled to take, and that will be a good position compared with the companies who are now paying 5 and 6 per cent. There is one point that I want to draw your attention to. We have put some £50,000 into the Western Union Company, and it is a very singular and very satisfactory thing for us that these 5 per cent. debentures are guaranteed by the Western Union Company. Still I am anxious that an international character should be given as much as possible to submarine telegraphy. We follow the flag, and the result of it is that wherever there is civilisation, we are participating in the growth of the place. The Western Union Company is a very powerful company in America, so powerful indeed, that I doubt if there is any company that possesses a greater area than the Western Company, and their guarantee is consequently a very good one. In the face of all this there are always some people who think there are not sufficient cables in that climate at present, and I see in the papers that another cable is contemplated. I would say that a fifth wheel to a carriage would be very useless, and not at all ornamental, and that would be the case if another cable were added. If instead of having 10 cables in the Atlantic there had been 8, everything would have been satisfactory, but those two make the difference. Whatever position the various companies occupy, we must watch them closely; what we desire to see is that they will prosper, because we know we have a corresponding prosperity. With these remarks I will move that the report and accounts for the year ended 1889, submitted to this meeting, be, and hereby are, adopted, and a dividend paid of 3s. per share on the preference, and 4s. on the ordinary, income tax having already been deducted, making, with previous payments, a total dividend of 6 per cent. on the preference shares, and 4½ per cent. on the ordinary shares.

The Marquis of Tweeddale seconded the motion, which was carried unanimously.

Sir John Pender and Sir James Anderson were then re-elected directors.

The retiring auditors having been re-elected, the usual vote of thanks brought the meeting to a close.

The Anglo-American Telegraph Company.

THE ordinary general half-yearly meeting of this company (the report of which was published in the REVIEW last week) was held last Tuesday at Winchester House. The Marquis of Tweeddale officiated as chairman.

The Secretary, having read the notice convening the meeting and the minutes of the last meeting,

The Chairman said: In moving the adoption of the report, which I presume you will take as read, I have in the first instance to apologise for the absence of our esteemed chairman, Lord Monck, who has been advised by his medical attendant to take a few weeks of complete rest, and I have no doubt we all hope this will restore him to his usual health. In submitting the report I shall have a more than usually agreeable duty to perform, because, although the dividend which we propose to pay is not a large one, and is certainly not sufficient to remunerate those who place their capital in such insecure property as cable property in the Atlantic, it is still by far the best dividend we have been able to pay for several years past; indeed, since 1884. Of course you know the increased receipts are due to the increase which took place in the rate, the rate has been doubled, and the number of messages has practically remained the same. This is a very satisfactory feature, and is more so because the six months under review are the least productive six months of the year. Already there is an increase in the receipts since the close of the year, and there is every reason to believe that by the time we meet you again a still more favourable result will be submitted. It must be satisfactory to you to know that while the receipts have doubled the expenses have remained practically stationary. It is true that if you examine closely the figures under B and C you will note that under one or two heads there is an increase, but these increases are exceptional; for instance, under the head of assurance there is an increase of a little over £500, this is due to payment to one of the superintendents, who was unable when the assurance fund was started, on account of ill-health, to take up his share in that fund; that will not occur again. In the same way, under the head of maintenance of land-lines, you will observe an increase of £300; that is due to the removal of a land line from the roadside to the railway, a very great improvement, both in economy and in efficiency. Our repairing ss. *Minia* has been occupied in making certain repairs on the south side of the Atlantic, and has also been profitable to us in making repairs for one of our partners, and, above all, in a very satisfactory manner removing the St. Pierre Duxbury section, a cable which we have alluded to before, and which has given us constant trouble and expenditure; the removal to its present position will be of great benefit to us, and will lead to considerable economy. The announcement of a cable breaking, which would have created consternation at one time, is now received with comparative equanimity; this is due to the skill and experience of those who conduct the expeditions for repairing such. After referring to the recently broken line, the noble Chairman said: I do not think there is anything else for me to refer to. The lawsuit is still going on in France; the appeal may be expected to be heard in course of time. With these observations, I beg to move the adoption of the reports and accounts.

Sir James Anderson seconded, and Mr. Smith supported.

Mr. Jackson thought more ought to be made out of the concern than was being done.

After a few remarks had been replied to by the Chairman, the report was accepted.

The usual vote of thanks terminated the proceedings.

Direct United States Cable Company, Limited.

THE twenty-fourth ordinary general meeting was held on Friday last at Winchester House, Sir John Pender in the chair, the directors report of which was published in our last issue.

The Secretary having read the notice convening the meeting, and the minutes of the last meeting,

The Chairman said: Before moving the adoption of the report, I will make a few remarks. The revenue for the half-year to 30th June, including income tax refunded, £299, and after deducting outpayments was £39,626, and the working and other expenses, exclusive of costs of repairs, £16,676, leaving a balance of £22,950 as the net profit of the half year, making, with the £11,641 brought from the previous half-year, a total of £35,592, interim dividend of 3s. 6d. per share for December last, £10,624, similar dividend to the 31st March last, £10,624, the proposed final dividend of 3s. 6d. for the quarter to 30th June last, £10,624; total, £31,872; leaving a balance of £2,712, which we propose to carry forward. The revenue for the half-year shows an increase of £22,118, as compared with the corresponding period of last year; but the tariff was then only 6d. per word. The expenses in London under Abstract A are so very nearly the same as in the corresponding period of last year, that a comparison of details is

unnecessary. The salaries at the stations are £273 higher, owing partly to some little increase which it has been necessary to make in the pay of the operators, who have had no advancement for some years past. Maintenance and renewals of instruments cost £250 extra, principally by reason of the adoption of the recorder instruments at our main cable stations, and from which satisfactory results have been obtained; travelling expenses, repairs and renewals, I believe, show a reduction of £35 and £32 respectively. With the exception of the expenses connected with the action of the Anglo Company and the French Company, which is quite of a special character, the remaining items of expenditure are practically unaltered. On the 19th April last the main cable was broken on the Green Bank by a ship's anchor. The Telegraph Construction Company's screw steamer was at once despatched to the position of the break, and the cable was restored on the 19th May, the total cost, including the cable used, was £4,474 1s. 11d. A portion of the cable taken up during these repairs was found in excellent condition, though it has been submerged 16 years (this was afterwards placed on the table). The reserve fund account, after being credited with interest on the investment and profits and sales of securities, and debited with cost of repairs, now amount to £242,048; it is on this occasion proposed to further increase the reserve fund. The cables have cost a considerable amount during the last twelve months. I have a letter, received this morning, from Dr. Muirhead, in which he refers to the tests recently taken of the main cables, and he says he has no hesitation in saying that they are practically as perfect to-day as they ever were. As you are aware there was a time when we believed that ten years was something like an average life of a cable, we can now say it is more like twenty years. I think that shows you that we are perfectly satisfied with the present position of our cable. After briefly referring to the shilling tariff and the lawsuit, which he considered was going on satisfactorily, the motion that the report be adopted and the dividend paid was carried.

The names of Sir H. Keppel and Admiral Mayne were then put before the meeting for re-election as directors, which was carried, Mr. Guesden showing his disapproval by voting against it.

The auditors were then re-elected, and the meeting closed with the customary vote of thanks to the chairman.

United River Plate Telephone Company, Limited.

IN the report of the directors, to be presented to the shareholders at the third ordinary general meeting, to be held at Winchester House, 50, Old Broad Street, E.C., on Thursday, the 8th August, 1889, at 12 o'clock noon, the directors beg to submit to the shareholders the accompanying balance sheet and profit and loss account, showing the result of the company's operations during the year ending 31st March last.

That result, after paying all working expenses abroad, debenture interest, London and other charges, is a profit of £32,850 13s. 10d., from which has to be deducted the sum of £14,689 6s. 8d. for loss on exchange, leaving a net profit of £18,161 7s. 2d., increased by the balance of £1,666 2s. 6d. brought forward from the previous year, to £19,827 9s. 8d.

Out of this an interim dividend of 3 per cent., or £8,250, was paid in January last; and the directors recommend that out of the remaining balance of £11,577 9s. 8d., a further dividend of 3 per cent., or 3s. per share, free of income tax, be now paid, which absorbs £8,367 2s. 6d.; that £2,000 be placed to the depreciation and renewal fund, thereby increasing it to £7,000; and that the balance of £1,210 7s. 2d. be carried forward to the credit of profit and loss account for the current year.

The directors record with satisfaction that the 5,000 new shares referred to in their last report, and offered to the shareholders *pro rata* in August last, were readily subscribed for, and the shareholders will observe that the capital expenditure during the year amounted to £35,070 2s. 11d., which, however, includes the purchase of the additional business at Rosario, mentioned in the directors' last report, and to meet the cost of which, 3,000 shares were issued to the vendors, the share capital issued being thereby increased to £290,000, as shown in the balance sheet. With this purchase, and the amalgamation consequent on it, the company's business at Rosario is fully consolidated; and the further capital expenditure during the year has placed the company's whole system in the Argentine Republic on a sound and efficient footing.

The directors have pleasure in pointing out that, as shown by the figures in the balance sheet and profit and loss account, the business of the company has steadily and considerably developed and increased in the past year, the gross receipts in the River Plate for the year having been £81,866 2s. 4d., as against about £66,092 for the preceding twelve months. The net results, however, have been affected by the loss in exchange, an item absolutely beyond the company's control, which amounted to £14,689 6s. 8d., as against £10,775 19s. shown in the previous balance sheet. The directors are now considering the advisability of adopting measures in some degree to meet this loss in exchange; while they are glad to say that the reports received from Buenos Ayres since the 1st April continue to show a steady increase in the company's receipts.

In accordance with the understanding at the last general meeting, Mr. George Cooper and Mr. Alfred Le Rossignol joined the board, and have since given the company the benefit of their experience in the River Plate.

Under the articles of association, Mr. Frank W. Jones and Mr. Thomas Lloyd retire by rotation at this meeting. Mr. Jones, being eligible, offers himself for re-election, but Mr. Lloyd does not seek re-election. Major Henry Fitzgerald has also resigned, and, while the board have received Mr. Lloyd's and Major Fitzgerald's resignations with great regret, recognising their services to the company, they do not propose any other gentlemen to take their place, as the board will thus be reduced to the original number of seven, which reduction, as explained at the last general meeting, has been for some time contemplated.

The auditors, Messrs. Cooper Bros. & Co., also retire, but offer themselves for re-election.

N.B.—If the dividend herein recommended be approved at the meeting on 8th proximo, the warrants will be posted to the shareholders that evening.

The Telephone Company of Austria, Limited.

IN the report presented at the sixth ordinary general meeting of the company, held at the offices of the company, 53, New Broad Street, on Wednesday, the 31st July, 1889, for the year ending 31st March, 1889, the directors state there has been expended on capital account a further sum of £8,546 5s. 10d. The gross receipts from all sources were £13,969 6s. 5d. After providing for all expenses, including £3,604 10s. 6d. for debenture interest and preference dividend, and £2,206 9s. 10d. for royalties and taxes to the Austrian Government, there remains a net profit of £2,352 10s. 5d., which, with the amount, £931 14s. 1d., brought forward from last year, leaves a balance to the credit of profit and loss account for the current year of £3,284 4s. 6d.; this amount it is proposed to carry forward.

There is a continued increase in the number of subscribers to the company's exchanges, as shown by the following table:

	No. of Subscribers.	Increases over previous 12 months.	Rental.	Increases over previous 12 months.
31st March, 1888	2,036	245	161,801 fl.	21,618 fl.
31st March, 1889	*2,299	263	182,550 fl.	20,749 fl.

Installations in the towns are still progressing at the usual rate, and so far as the board can judge, seem likely to continue to do so. The calls of subscribers now average over 64,000 per week, as against 60,000 last year.

The Austrian Government having decided to run a trunk line from Vienna to Prague, your directors are now erecting, at a very heavy cost, a new and improved switchboard at their Prague exchange, to correspond with the system in use in Vienna. This expense was undertaken in the first instance with the view of assisting the Austrian Government in their endeavour to carry out successfully their scheme of inter-urban telephony, but will also become a productive outlay as increased and improved switchboard accommodation will, in a time not far distant, become necessary, owing to the constantly growing number of subscribers in that city.

The question of the prolongation of the company's concessions is now under the consideration of the Government, a very carefully considered petition having been laid before the Minister of Commerce, and it is expected that the matter will be decided this autumn.

The transmission and delivery of telegrams by the company's exchanges has very considerably increased during the past year, the number of messages dealt with averaging 2,150 per week, and although this service has not yet proved remunerative to the company, its advantages indirecty are very great, and sufficient to justify its continuance.

The cordial and satisfactory relations of the Imperial Royal Government Telegraph and Postal Authorities and municipal bodies with the company remain unaltered.

It is with regret that the directors have to announce the retirement from the Local Board in Austria of Mr. Joseph Wessely, owing to ill-health. The thanks of the shareholders are again due to him, and very specially to Dr. Eugen Weissel, for their continued services during the past year, as also to Mr. R. Howard Krause for the highly satisfactory manner in which he continues to perform his duties as general manager.

Mr. C. L. W. Fitz-Gerald retires by rotation from the board, but being eligible, offers himself for re-election.

The directors, to meet the wishes of the Consolidated Telephone Construction and Maintenance Company, Limited, have invited Mr. Joseph Hicks Buckingham to a seat on the board, and will propose his election accordingly.

The auditors, Messrs. Deloitte, Dever, Griffiths & Co., also retire, but being eligible, offer themselves for re-election.

The meeting was held on Wednesday, but our representative not being admitted we are unable to give a report of the proceedings.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts for the week ended 26th July, 1889, amounted to £3,163.

The Western and Brazilian Telegraph Company, Limited. The traffic receipts for the week ending 26th July, 1889, after deducting the fifth of the gross receipts payable to the London Platino-Brazilian Telegraph Company, Limited, were £1,697.

* Exclusive of 142 "Extension" telephones, which were erected during the year, giving an additional annual rental of 4,510 fl.

ALTERNATE CURRENT WORKING.

THE following is the text of Mr. Mordey's reply to the discussion which took place on his paper read before the Institution of Electrical Engineers on May 23rd, reprinted from the proceedings of the Institution.

Mr. W. M. MORDEY said:—I wish in the first place to express my thanks for the very kind way in which you have received this paper. The criticisms have, in some cases, been answered by other speakers. The remaining points in regard to which the speakers are not in accord with me I must deal with so far as I can in the time at my disposal, but I need not occupy time by referring to other matters.

Dr. Hopkinson's statements on electrical subjects are always received, not only with great respect, but as being usually correct and final. I join in the respect, but venture to question the correctness in this instance. If Dr. Hopkinson would be better satisfied by my stating that the most perfect alternator conceivable is one which has an indefinitely small self-induction and resistance, I am quite prepared to express my meaning in that way. I was acquainted with the general practical results, as regards parallel working, brought before us in 1884 by him, but, for reasons which will be understood, I did not derive any assistance from his theory, nor do I now agree that that theory "is sufficient to predict all the results obtained." I cannot fully argue this point, but must ask Dr. Hopkinson if he will kindly look into it again, for I am strongly of opinion that he will find that it is not as complete as appears to be supposed. I am the more convinced of the correctness of my explanation by the measurements of the self-induction of my armature by Prof. Ayrton's assistants, using the new Ayrton and Perry instruments, and by the statement made by Prof. Ayrton that the time-constant, or ratio of the self-induction to the resistance, was about the same in my machine and in that of an alternator of another maker, which latter machine only exhibited very feeble synchronising properties when attempts were made to run two of them in parallel.

The point where mathematical treatment of the subject appears to have failed is that it has not taken sufficient account of the "stiffness" of the field. This is at once apparent when this measurement of the self-induction of one of my machines is referred to, from which it will be seen that the self-induction was practically the same whether any impressed field existed or not. Manifestly, with no impressed field, the controlling power of the machine would be quite inconsiderable, although the values of self-induction and resistance—upon which Dr. Hopkinson relies—would be the same then as when the machine was working with a strong impressed field and under the conditions giving the maximum generating and controlling power. Hence it is evident that a theory which only takes cognisance of self-induction and resistance must be altogether illusory.

There are several reasons for the view that his theory is incomplete. His paper has been before the world for several years, and has been often studied, but neither its author (who has been engaged on the subject) nor anyone else has ever based any practical advance on it. Working parallel has been recently considered, as a question of great urgency and importance, before this Institution and elsewhere, and there have been abundant opportunities for bringing forward any useful information, but the whole subject was misunderstood; and Dr. Hopkinson, who has been a witness of the struggles that on all sides were being made towards a better understanding of it, has remained silent. I am sure that nothing would be more unlike him than to let the whole industry suffer for want of a little clear and definite information, if he had been able to give that information. Dr. Hopkinson even took part in the discussion on Mr. Kapp's paper a few weeks ago, and threw no light on this question, thus tacitly subscribing to the current views.

It would be easy to find several other instances, besides those mentioned in the brief enumeration in my paper, to show that the views generally held were entirely misleading and incorrect. For example, Mr. Swinburne alludes to* Dr. Hopkinson's mathematical treatment, and says that he has put the matter into English in his book;† and I find in that (recently written) book it is stated (on p. 151) that there are no alternate-current motors. But nothing less than the actual words can show how completely misleading this theory was. Mr. Swinburne proceeded, in the book in question: "It seems generally to be assumed that the only difficulty with alternating current motors is to start them. It seems probable, however, that there will be very great difficulty in designing a motor which will work with reasonable efficiency and varying load. An alternating is a widely different thing from a direct current motor."

Having seen all these statements disproved—having seen a 50 H.P. synchronising motor running with high efficiency under varying load, and designed on the lines of a direct current motor—Mr. Swinburne now comes forward and says:‡ "I see nothing in Mr. Mordey's interesting experiments which conflicts with the recognised theory; in fact, *the position of synchronous motors is not altered*"—the italics are mine. Truly the Hopkinson theory, as rendered into English, must be capable of infinite elasticity.

Then again, only a few months ago, Mr. Swinburne, who had assimilated this theory, stated‖ that such machines as mine would not run in parallel at all, and he described an "induction-coupler" which he had devised for the purpose of making them so run by inserting self-induction. That device is a very good illustration of the results of the old theories. I may mention that when I was labouring in the slough of those old theories I independently devised that identical arrangement, which is one quite in accord with the requirements of those theories, so far as I was able to understand them; and having entirely failed to get two ironless alternators of a well-known type to work parallel in their simple condition, I tried that "induction-coupler" without any improvement in the result. That was, in fact, one of the experiments that opened my eyes to the whole fallacy. It helped me to see that anything that prevented the instantaneous passage of the necessary correcting current must inevitably tend to prevent synchronous action.

Referring to Prof. Adams's criticism, I may say that I was fully aware of his experiments at the South Foreland Lighthouse, and referred to them. Prof. Adams considers those experiments as conclusively establishing Dr. Hopkinson's theory. I need not again consider them in that connection, but would only say that the motor effects obtained were not powerful, and that they have not been taken as forming a basis for practical construction. Indeed, they have remained on record as the not very high tide-mark beyond which no substantial advance was found practicable, until machines having very different qualities were developed. It would cause me no surprise to find that the South Foreland experiments succeeded from quite different causes than those imagined by Prof. Adams. It is not at all clear that any of the advocates of Dr. Hopkinson's theory really understand what that theory is. It seems to cover a multitude of quite opposite interpretations, and resembles some of the Hebrew prophecies in its comprehensive applicability to occurrences—after the event. Prof. Adams, I am afraid, rather supposes that I make some sort of claim to having introduced parallel working. The object of the first portion of my paper was rather to state what lines I thought should be followed in order to obtain the best results, and to show that on those lines complete success could be attained at a time when, in spite of Prof. Adams's well-known and valuable paper, considerable and well-founded doubt existed as to the commercial possibility of parallel working. In one respect, however, I am quite unable to follow Prof. Adams, and that is in some of his analogies between alternators working parallel and tuning-forks vibrating in unison. He says that I gave the octave when I had one machine working at 1,000 volts and the other at 2,000 volts, both being at the same speed, and he suggests that I should give the double octave, and various other ratios. Now I fail to see that there is any true analogy between various rates of sound vibration produced by tuning-forks and corresponding ratios of electrical pressure. It would be just as correct to say that a steam boiler with a pressure of 120 lbs. on the square inch was giving the octave of another boiler working at 60 lbs.

As to the very different problem of running alternators parallel when the alternations are an octave of one another—a possibility that is also put forward by Prof. Adams, and which has been mentioned to me by Mr. Sumpner and others—I can only say that I have not tried it, partly because it does not hold out any promise of a useful result if successful, and partly because I feel pretty sure it would not succeed, except with machines having so much self-induction as to render them unsuitable for practical purposes. A little consideration will, I think, show that this must be the case.

Prof. Adams refers to the loud humming noise made by my alternators when they were connected parallel while out of phase as "very sufficient evidence of very considerable self-induction, in consequence of which the speed of one machine is suddenly increased, and of the other as suddeniy diminished." This noise is really a proof of the contrary. It is caused by the enormous rush of current which the comparative absence of self-induction renders possible, and this momentary rush puts the machines in phase with a jerk. As bearing on this point, I may mention that some machines that are said to have large self-induction do not make this noise under the same circumstances. Their self-induction prevents any such rush of current, and, according to my view, also prevents their working parallel. Although dissenting from my explanation, this rush of current is recognised by Mr. Swinburne (p. 656) as a proof of absence of self-induction.

It is interesting and important to consider another action arising out of this matter. In several machines—some with and some without iron—the self-induction is so serious that it does as well to short-circuit armature coils as to cut them out when it is desired to reduce the potential difference at the terminals. In fact, these machines cannot be injured by accidental or intentional short-circuits. They obtain this advantage, however, at the cost of every other good quality. The rush of current, the effect of which Prof. Adams noticed, but misunderstood, in my machine, could not take place with such high self-induction machines. They could be put into connection when out of phase, and would simply choke back the current which attempted to put them into step.

I think there is no real difference of opinion between Major Cardew and myself on the subject of safeguards. I quite agree with him that the two contacts, *a* and *b*, may be "ready waiting" for a person to make the other two contacts and so receive a shock. It is to prevent the possibility of this that I so strongly recommend earthing. It is an absolute safeguard, costs nothing, and does not cause interference with telegraph or telephone service. I cannot admit that it increases fire risks. I think it lessens them,

* The *Electrician*, June 14th, 1889, p. 154.
† "Practical Electrical Measurement."
‡ The *Electrician*, June 14th, 1889.
‖ *Journal*, vol. xvii., p. 401.

because it makes it certain that a faulty transformer or house circuit cannot remain on. The safety fuse on an earthed circuit instantly cuts off a faulty house, and so prevents that gradual accumulation of unsound or actually defective places that, without some such safeguard, would soon render a large supply service unworkable. As to the supposed excessive strain on a 100-volt circuit if it is earthed, that does not exist in practice. The secondary is earthed in the middle, so that the strain is really only 50 volts; and an installation that will not stand that strain is radically bad and ought not to be allowed anywhere. The great advantage of earthing is that it secures safety, protects the customer against bad work and leakage through his meter, and protects the system against the presence of rotten installations. If the fire offices do not see before long that earthing does not increase fire risks, I shall be greatly surprised.

One or two points in Dr. Fleming's remarks require some reply from me. His suggestion to account for the behaviour of transformers with different periodicities is, I think, very pretty and very ingenious. At first I could not fully accept it, as the greater penetration of the eddy currents into the iron at a low periodicity seemed to be an effect that would not be likely to be felt with very thin conductors, such as the laminated iron (see under "Conductors"); but I now see that the currents in the laminations, although very close together and insulated from each other, can act on one another and produce the "virtual resistance" effect.

Prof. Fleming's objection to my substitution of the word "magnetisation" for "induction" is not a very strong one. I have only to say that I think "induction" would not be a good word even if it had not already been secured for a dozen other purposes. Some limit should be placed to the multiplication of meanings given to this one word, which, after all, is not an electric or magnetic word at all.

Mr. Kapp has latterly given much attention to this subject of alternate current working, and understands its difficulties. On this account, and also because I was obliged to strongly oppose some of his views, I highly appreciate his kind remarks about the paper. He accepts all my facts, but rejects my interpretation. He will, I feel sure, accept them both on further consideration.

The experiment of which he suggests an explanation, which is in some respects similar to the explanation proposed by Sir William Thomson, is no doubt a very interesting one. It is a case not very likely to occur in practice, but deserves attention. I do not, however, quite agree with Mr. Kapp and Sir William Thomson. I wish their explanations were more convincing, and were not so much opposed to Prof. Ayrton's measurements of the self-induction with different relative positions of armature and field, and with various field strengths, which showed that the actual conditions are exactly the reverse of those relied upon in Mr. Kapp's supposition.

I think that in any case the actual magnetising or demagnetising action exerted by the armature on the field magnet must be small, partly for the reason, pointed out by Prof. Silvanus Thompson, that there was not time in a half-period for the solid iron to undergo any change, and partly because the armature is purposely made so as to exert as small an effect of that kind as possible. The machine consists of a very powerful electro-magnet, the field; and a very weak electro-magnet, the armature. Even if coils similar to the armature coils were wound on the extremities of the polar horns, and had a direct current sent through them equal to the maximum working alternate current, they would not produce a very powerful effect on the field.

One of the difficulties met with in considering this question is that there is no means of knowing which machine was generator and which motor. This depends, of course, upon the relative power of the engines. It is quite possible that the lower E.M.F. machine was acting as the generator.

I can only say that I will take the first opportunity of acting on Sir William Thomson's suggestion as to testing the supposed changes of magnetisation, and hope thus to be able to settle this question.

Mr. Swinburne challenges my conclusions on several points with his usual vigour, and I very willingly take up the gauntlet. I have already alluded to some remarks of his which place him in the honourable light of an interpreter of Dr. Hopkinson's mathematics. The position is one that requires great powers of endurance and considerable courage.

Mr. Swinburne says that "electrical engineers do not realise what is wanted in parallel running." I accept this candid statement as, at any rate, quite correctly describing his attitude in the matter; and am, therefore, of course, prepared to find that he disagrees with most of my views.

He commences by stating that so far from the motor being kept in step because its self-induction was small, that, if there were no self-induction, the generator would have no control at all over the motor.

This is an instance of a very common mistake—that of supposing that if there is practically no self-induction there can be no generating or motive capability. The exact contrary is the case, as I tried to explain in the paper when I expressed the view that "a perfect alternator for any and every purpose should have no resistance and no self-induction" (page 591). Of course this condition is unattainable in practice. It is a mere expression of the direction in which it appeared desirable to advance; and, as I have already said, I am prepared to put it that the most perfect alternator conceivable is one which has an indefinitely small self-induction and resistance. This idea that the generating or controlling power is connected directly with the self-induction is clearly upset by the fact, shown by Prof. Ayrton's experiments, that the self-induction is not sensibly altered by variations of the field strength or position. I need scarcely repeat that the generating or controlling power depends almost entirely on the field strength and position relatively to the armature.

But Mr. Swinburne sticks to the ordinary fallacy, and says—or implies—that such a machine would not act at all either as generator or motor, and reproaches me for attacking existing theories without giving one of my own to take their place. Even that course would have been quite justifiable if I had found the existing theory bad. But I have given a theory. I have said what I thought a perfect generator or motor should be, and have attempted to explain the *rationale* of the action of two such machines when controlling each other. Let me take a case. The armature of my machine has a certain resistance and a certain self-induction. These qualities are unfortunately unavoidable, but I made the machine as good as I possibly could by reducing them both. This was done by the use of a strong and "stiff" field. Need I explain that, if the properties of iron had permitted it, I should have been able so to increase the field as to allow of a proportionate reduction of the resistance and of the self-induction of the armature? And if I could have got an indefinitely strong field I should have reduced the armature resistance and self-induction also indefinitely. Then I should have the "perfect alternators" that I alluded to working as generators or as motors, singly or parallel.

But Mr. Swinburne, bearing out his opening statement, implies that such machines would not work at all.

Then, again, speaking generally, he says: "To make them run parallel commercially needs a large corrective tendency. This can only be got by making the machines so that the maximum current is not at the same time as the maximum E.M.F." This is exactly the opposite of the actually best conditions. Of course they need a large corrective tendency and great stability, as Dr. Fleming says. I urged this strongly in my paper (page 591). Inverting Mr. Swinburne's statement—which really means that the machines must have large self-induction—I say this large corrective tendency can only be got to its fullest extent by making the machines so that the maximum current is at the same time as the maximum E.M.F., at any rate when working on an inductionless circuit. Mr. Swinburne quite correctly interprets the restriction imposed by the conditions he thinks best when he says "that the machines must be made larger to give a given output. They must also be somewhat less efficient." The whole object of the first section of my paper was to show that such views were both practically and theoretically wrong, and I am surprised that a literal restatement of them should now be put forward.

The best practicable alternator for any and every purpose should have the lowest practicable resistance and self-induction. It will not be larger for a given output or less efficient. It will not have its maximum current at a different time from its maximum E.M.F., and it will exert a large corrective tendency in the most powerful and unhesitating manner, and will maintain synchronism with the least difference of time-phase between any two machines. Such are the views to which I am driven by the logic of facts. On one point I agree with Mr. Swinburne—that if a large corrective margin is required, the internal loss must be large; but even here we do not fully agree. With the old theories the corrective margin was out of all proportion to the effect required to be produced. By the sudden and strong action I obtain by departing as far as possible from the old theories, I get this large corrective margin of power by a small margin in the capacity of the machine. It is obviously unwise, however, to attempt to run machines parallel when they require to exert a large controlling power. My experiments showed that they could exert this power; but the driving plant that requires large control is not suitable for parallel working.

Mr. Swinburne's calculations on the efficiency and dimensions of transformers are, I am sure, very interesting; but I scarcely think we are yet in a position to settle these matters entirely on paper. There are so many variables, and there is so little actual knowledge of the laws governing the heating by eddies and by hysteresis in transformers, that it is probably best to rely mainly on experiment for the present. Thus Prof. Ewing says (page 642) in his letter: "We cannot be sure that the loss by hysteresis is proportional to speed, especially when the speed is high;" and my experiments on armature cores support this view. Mr. Swinburne, however, is sufficiently sure on this and all the other points to rely upon his calculations for transformers working under widely different conditions. I admire his courage, but advise him to be prepared for disappointments when the transformers are constructed. I cannot at all agree, either, that the eddies in the iron are negligible, in spite of any calculations showing them to be inappreciable. It will be found that my tests bear out very closely the results as regards loss that are known to be obtained in low period direct current machines. Those experiments confirm, as regards hysteresis, the results of Ewing and Hopkinson; and as to the eddies, it is open to any one to check them by experiment or by reference to any reliable tests. I would, however, point out that in the celebrated paper of the Drs. Hopkinson on "Dynamo-electric Machinery"* one of the two power readings which are available for this purpose is wrong, the total loss of power being given as less than the calculated hypothesis loss. I have pointed out this discrepancy to Dr. Hopkinson, and find that he is aware of it. It was no doubt an incorrect reading.

Prof. Silvanus Thompson and Prof. Forbes ask for information

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* *Phil. Trans.*, Part I., 1886.

as to the governing of the engines driving the two alternators in the experiments. Those engines were not governed automatically at all; they were simply controlled by hand. Of course, if they had been well governed automatically, the tests would have been much less severe. As it was, it was left to the engine driver to give each engine as much steam as he thought was necessary. In such a case, if one engine is more powerful than another, the power of mutual control is severely tested; if the engines are working under similar conditions, then the corrective margin is not required to be large. The utmost strain is put on the arrangement when, as was done in the experiments, steam is entirely shut off one engine.

I trust Prof. Thompson will continue his very interesting experiments on the seat of the back E.M.F. in arcs. The subject requires investigation. The method used will probably yield useful results as regards a comparison between direct and alternate current arcs. There is one point to which I wish to draw Prof. Thompson's attention, and that is whether there is, in an A.C. arc, an effect of the opposing E.M.F. in producing a displacement of the current phase. I suppose it may be taken as proved that the arc has an E.M.F. as well as a resistance; and with a rapidly alternating current it seems possible that this may produce a lag, and may act in that respect something like electro-magnetic self-induction. Such an effect may, perhaps, also be found in A.C. electrolysis. I note Prof. Thompson's criticism of my statement that in the characteristic the drop is partly due to resistance and partly to self-induction. He does not say that I am wrong. Several effects are produced by the currents—eddy and useful—generated by motion, and it is, I think, allowable to describe the net result on the characteristic as due to self-induction.

I have already referred to Prof. Thompson's expression of doubt as to whether there is time in a half period for the large mass of iron in the polar horns to become magnetised. He is probably quite right, but I have had no opportunity of settling the point. If there is any effect it will probably be almost a steady one, as pointed out by Sir William Thomson; that is to say, the iron will not follow the varying impressed magnetising force, but will take up an average state, depending upon the current and the relative position of armature and field.

Prof. Ayrton, in his opening words, appears to ally himself with the views that I have sought to upset; but I have to thank him for having contributed an account of experiments which, perhaps more than anything I can say, tend to support my contention. He referred to the method of testing transformers that I suggested. That method may be safely used, except with a very inefficient transformer.

As to the curves of temperature, I can only say that I have no reason to doubt the accuracy of the tests, which were most carefully carried out.

Prof. Forbes pointed out that it is wrong to suppose there are only two means of distributing alternate currents. I quite agree with him; but although I have dwelt at some length on the subject of working parallel, I do not think that method is suitable for all cases. It is a great convenience, and in a properly designed station can always be adopted; but where, either from the design of the machines or from the character of the engines, a large corrective margin is necessary, then it may be better to work singly, putting such of the mains in parallel on one machine as may be convenient.

If the alternators are suitable for parallel work, then the different mains may be run parallel from a common or omnibus pair of terminal bars, each main being fed through a safely fuse, in order to prevent more than local extinction in case of a short circuit.

With regard to Mr. Zipernowsky's communication, I am sorry he should think the statements I made about working his alternators parallel are erroneous. Those statements are substantially quotations from his own writings. He objects to a passage in my paper in which I said that his reason for working at the very low periodicity of 42 was to enable him to run the machines parallel. My authority was his own letter, published a few days before my paper.* In this letter—to quote it more fully—he said: "The relatively low number of alternations (5,000 per minute), which we have chosen on principle . . . . that we by this means are enabled to couple our dynamos in parallel is not a secondary result, but just the end we were aiming at." Mr. Zipernowsky now writes (page 672): "We state that we have not reduced the periodicity because of the coupling in parallel."

I must leave these two opposed statements to speak for themselves.

The other statement which Mr. Zipernowsky questions is that the magnetic flux in the field ought to be constant, and I am blamed for not giving my reasons for this statement. I did not go into the matter very fully, as it seemed unnecessary; but when I said that want of constancy "necessarily led to losses in the field, the lamination of which in the Zipernowsky machine showing that such losses must be serious." (page 629), I am sure I sufficiently indicated the nature of the waste which occurs under the conditions referred to.

I am glad to have elicited Mr. Zipernowsky's remarks about the Ganz alternate current motor, and shall look forward to seeing an actual description of that apparatus. The publications on that subject, to which my attention is called, are remarkable for the small amount of definite information they contain. I can learn nothing from them. We are not told anything at all about the form, mode of action, or principle of the machine. There are no doubt good and sufficient reasons for this reticence.

Of Mr. Fricker's contribution I need only say that it is a very clear statement, with which I wholly agree.

* The *Electrician*, May 10th, 1889.

THE ELECTRIC LIGHTING SCHEMES.

Bills before the Commons Select Committee.

PROVISIONAL ORDERS CONFIRMED.

(Continued from page 111.)

On Thursday, as soon as the Committee were ready to commence,

Mr. MOULTON expressed a desire, as the Committee were that day going to hear the opposition of the gas companies, to direct attention to the clauses in the Provisional Order granted to his company—the London Electric Supply Corporation.

Mr. POPE: I object to this. He is not entitled to make a speech in favour of the Bill which is submitted to you.

Mr. MOULTON: I desire to point out to the Committee the origin of the works' clauses in the provisional order.

The CHAIRMAN: I think we had better pursue the course we pursued yesterday, and allow the counsel who has charge of the clauses to begin. Will you refer me to the clauses in the order to which you refer?

Mr. MOULTON: They are 16, 17 and 76 (as to altering pipes, wires, &c., under streets; the laying of electric lines, &c., near those of gas or water companies, and near sewers, drains, &c.; and for the undertakers to be responsible for damages).

Mr. POPE (who, with Mr. Bidder and Mr. Danckwerts, appeared for the Gas Light and Coke Company), in bringing up the clauses which he said ought to be put in all the provisional orders for the protection of the gas companies, stated that the discussion, in all probability, would to-day practically settle a series of model orders which would be adopted in the provisional orders as affecting all the gas companies. The Gas Light and Coke Company was, of course, the largest corporation undertaking the supply of gas in the metropolis, and it so happened that by a series of amalgamations sanctioned by Parliament that company had the supply of gas covering the whole of the area affected by the provisional orders, and that was why the company attended there by counsel to discuss the question in their individual interest, although practically they were representing the interests of the gas companies generally. Had there been any pressure put upon him he should have declined, as representing the gas company, to bring forward clauses for the mere purpose of obstructing an enterprise which might be a competitor with the gas companies. But they had not put any such pressure upon him, for the gas companies were perfectly prepared to accept the competition which Parliament was about to sanction between the electric light and the gas, and all they desired was that the protection they were entitled to for their property and undertakings should be fair and reasonable, and that in the desire to encourage a new enterprise or undertaking, no wrong or injury should be done to those who were already in possession of the field. The position of the gas companies as to their rights regarding the works which they had executed was now pretty well settled in point of law. There were doubts entertained as to the rights of the gas companies in the pipes which they laid, and in the works which they executed for the supply of gas. There could be no question, however, that the state of the law was this—that the gas companies were there by statutory title, and had laid pipes in the public streets, and were entitled to precisely the same protection which any other owner of property was entitled to in regard to the safety and maintenance of property which belonged to them. They were entitled to this amount of protection—with regard to any Act which might injure their undertaking, and in respect of which they would be entitled to bring an action for damages, if that act was not done under the protection of Parliament. If damage were done to the main pipes or the gas supply of the company, they were entitled to have power to bring an action. Proper protection should be given to the company in respect of any right which was taken away from them. The law was that they were absolutely entitled to non-interference, and that if any damage arose from any act which was not jusiified by Act of Parliament, they were entitled to take action for damages, and to obtain a remedy. The provisional order operating as an Act of Parliament would enable the electric lighting company to do that which without an Act they could not do, except under a liability of compensation to the gas companies. He did not mean compensation in respect of competition, but in regard to any injury done. There were two important points which ought to be provided against. The first was as to danger. They ought not to be subjected to increased danger in the carrying out of their gas supply by reason of the powers which might be given to the electric lighting companies. Secondly, they ought to be allowed a protection wherein the laying of the mains and the construction of the works the electric lighting company should not, as it were, spread a net over the streets of the metropolis which would make it difficult or impede the gas company carrying on their own works for any purposes whatever. Those were the two

points to which the clauses were directed. The essential part of the clauses were not repugnant. Undoubtedly as long ago as last March clauses were agreed to between them and the Metropolitan Company, and there were clauses which for several years had, without exception, been given the Gas Light and Coke Company and other companies by every railway company which had interfered or proposed to interfere with their works or mains, and they had in fact inserted those clauses for several years past in all the railway bills. Mr. Pope then proceeded to read the clauses as follows:—

"By way of addition to, and not in derogation of, the provisions of the principal Act and of this order, and for the protection of the Gas Light and Coke Company (in this section referred to as 'the Gas Company'), the following provisions shall have effect (that is to say):—

"A. Whereas in the execution of the works (other than the alteration of the position of any pipe) by this order authorised, the mains, pipes, syphons and other works belonging to the gas company may be intersected or otherwise interfered with, and it is expedient that the gas company should have full control over the execution of all works in any way affecting the supply by them of gas, so as effectually to provide against the supply thereof being impeded, be it therefore enacted that all works, matters, or things (other than the alteration of the position of any pipe), which, under the provisions of the principal Act, or this order, the undertakers may be empowered or required to do or execute with reference to or within 5 feet of any of the mains, pipes, syphons or other works of the gas company, or which under the provisions of the principal act or this order are empowered or required to be done or executed by the undertakers, and may or does interfere with or prejudice the alteration, repair, user, or enjoyment of the mains, pipes, syphons, or other works of the gas company or supply of gas therefrom, shall be done and executed by and at the cost of the undertakers, but to the satisfaction and under the direction of and in such manner as shall be required by the engineer for the time being of the gas company; and such works, matters, or other things shall not be commenced until after 14 days' previous notice thereof in writing shall have been given to the gas company; and the undertakers shall not lay down any such mains, pipes, syphons, or other works so as to interfere with the observance of the regulations or directions of any Act of Parliament relating to the gas company. Provided always, that if the gas company shall elect themselves to execute any portion of the works, matters, and things which the undertakers may by this order be empowered or required to do or exercise with reference to or affecting the mains, pipes, syphons, apparatus, or other works of the gas company, and of such their election shall give seven days' notice in writing to the undertakers by leaving the same at their head office, the gas company may themselves execute that portion of the said works, matters, and things; and the reasonable expense of and incident to the executing the same shall be repaid by the undertakers to the gas company. Provided also that in cases of sudden emergency arising from defects in any of the pipes or other works of the undertakers which may require to be remedied without delay, the notice to be given as aforesaid shall be given at the earliest possible time, and not later in any case than immediately upon the commencement of the work. In default of any such notice as by this clause required being given, the undertakers shall (without prejudice to any other remedy of the gas company) forfeit or pay to the gas company a penalty not exceeding £20, and any expenses the gas company may incur through the absence of such notice.

"B. If any interruption whatsoever in the supply of gas by the gas company, or any loss or escape of gas shall be in any way occasioned or sustained by any act or omission of the undertakers, or by the acts of any of their contractors, agents, workmen, or servants, or any persons in the employ of them, or any or either of them, the undertakers shall indemnify the gas company against all penalties and costs to which the gas company shall become liable in consequence thereof, and in addition shall pay to the gas company the value of the gas so lost. If the undertakers shall find it necessary to undermine but not otherwise alter the position of any main, pipe, syphon, or other works belonging to the gas company, they shall temporarily support the same in its position during the execution of their works and on their completion shall provide a good and suitable foundation for every main, pipe, syphon, or other work so undermined.

"C. Nothing in this order shall authorise the undertakers to employ any of the works, mains, or pipes of the gas company, or any works, culverts, mains, or pipes in connection with those of the gas company, as supports for any works of the undertakers, or as conductors for the purpose of completing the electric circuit: and the undertakers are hereby prohibited from so employing any of such works, culverts, mains, or pipes, or from in any way bringing their electric mains, wire, or services into contact with or nearer to such gas works, mains, or pipes than shall be agreed upon between the engineer for the time being of the undertakers and the engineer for the time being of the gas company.

"D. Wherever an electric line, wire, tube, main, or other apparatus for the supply of electricity shall cross or be liable to touch gas mains, pipes or services, it shall be thoroughly encased in an insulating covering to the satisfaction of the engineer of the gas company for the time being.

"E. The expense of all repairs or renewals of the said pipes or mains, or any works in connection therewith, which may at any time hereafter be rendered necessary by the acts or defaults of the undertakers, their contractors, agents, workmen, or servants, or any person in their employ, shall be borne and paid by the undertakers.

"F. Nothwithstanding anything in this order contained, the undertakers shall be responsible for and make good to the gas company all costs, losses, damages and expenses which may be occasioned to the gas company, or to any of their mains, pipes, syphons, apparatus, property, works, and conveniences, or of any loss of gas or interruption in the supply of gas by the gas company, or otherwise, including injury and loss by explosion through, by reason of, or consequent on the execution or failure of any of the intended electric works and apparatus, or of any act or omission of the undertakers, or of any of their contractors, agents, workmen, or servants, or any of the persons in their employ or in the employ of their contractors or others, and the undertakers shall effectually indemnify and hold harmless the gas company from all claims and demands upon or against them by reason of such execution or failure, or of any such act or omission.

"G. Except in cases of sudden emergency arising from any defects in any of their mains, pipes, or other works which may require to be remedied without delay, the gas company shall not execute any work so far as it immediately affects the supply of electricity except under the superintendence of the undertakers, unless they refuse or neglect to give such superintendence at the time specified in the notice for the commencement of the work, or discontinue the same during the progress of the work; and the gas company shall execute such work at their own expense and to the reasonable satisfaction of the undertakers. Provided that any additional expense imposed upon them by reason of the existence of an electric line, wire, tube, main or other apparatus for the supply of electricity in any road or place where any mains, pipes, syphons, and other works belonging to the gas company shall have been laid before the passing of this order, shall be borne by the undertakers.

"H. Nothing in this order shall take away or abridge any power to open or break up any road along or across which any electric line, wire, tube, main, or other apparatus for the supply of electricity is laid, or any other power vested in the gas company, for the purpose of laying down, repairing, altering, or removing any pipe for the supply of gas or other work, but in the exercise of such power the gas company shall be subject to the following restriction (that is to say):—

"1. They shall cause as little damage or inconvenience to the undertakers as circumstances admit of.

"2. Before they commence any work whereby the supply of electricity will be interrupted they shall (except in cases of urgency arising from defects in any of their mains, pipes, or works, in which cases no notice shall be necessary) give to the undertakers notice of their intention to commence such work, specifying the time at which they will begin to do so. Such notice to be given 48 hours at least before the commencement of the work.

"3. Any difference arising between the undertakers and the gas company respecting any of the matters referred to in this clause shall be determined by arbitration.

"I. Except as is by this order expressly provided, this order, or anything herein contained, shall not take away, diminish, alter, or prejudice any of the rights, powers, privileges, or authorities of the gas company.

"J. Any difference (not being a question relating to a penalty recoverable summarily, or to an injunction or mandamus) which may arise between the gas company and the undertakers under or out of the provisions of the principal Act or this order shall, at the request of either party, be determined by arbitration. The award made upon any such arbitration may be enforced as though the same were a judgment or order of the Queen's Bench Division of Her Majesty's High Court of Justice. The Board of Trade, if it thinks fit, may at the request of either party appoint a legal arbitrator or a legal assessor to the lay arbitrator appointed by the Board. The remuneration of any arbitrator or assessor appointed by the Board shall be fixed by the Board, and shall form part of the costs of the reference."

Evidence was then given in support of the petition which had been read, and the first witness was

Mr. J. O. PHILLIPS, who (examined by Mr. BIDDER, Q.C.) said he was the secretary and general manager of the Gas Light and Coke Company, and had had 27 years' experience of the gas supply of the metropolis. Their district was the result of the amalgamation of many companies and embraced nearly the whole of the north of London, and a part of it south of the Thames. The total capital of the company was about £12,000,000, and the total annual sale of the gas was 19,000,000,000 cubic feet, representing 1,750,000 tons of coal.

Mr. BIDDER: You have mains, I suppose we might say, in almost every street in your district?—In every street, lane, court, and alley in the whole of the district.

And you light something like 55,000 street lamps?—Yes.

And you supply 206,000 private consumers at the present time?—Yes.

And you pay £150,000 a year in parochial rates?—Last year we paid for parish rates £160,000.

That is sufficient to enable the committee to understand the magnitude of the interests represented by the company. Your principal works now are down at Beckton?—Yes, below Woolwich, on the north bank of the Thames.

Besides those you have subsidiary works in different parts of London?—Ten of them.

I may take it that the whole of the districts which are the subjects of the provisional order before this committee are within your district of gas supply?—I think every one of them.

And, therefore, all electric light mains and pipes which it is contemplated to lay under these various provisional orders must necessarily be laid in streets already occupied by your gas pipes?—Yes.

And, of course, streets which are also partially occupied by water pipes as well?—Yes.

You have 1,850 miles of mains?—Yes, we have 1,850 miles of mains in the streets.

Those, of course, being of all sizes from 4 feet in diameter downwards?—Yes.

I think this question of the necessity of protection in case of electric mains being laid in streets has had your attention since so far back as 1883?—That is so.

In connection with the Electric Lighting Act of 1882?—Yes.

I believe at that time your company prepared clauses which were practically and essentially similar to those now before the committee?—Substantially they were the same.

Since that time so little has been done in the matter of the practical extension of electric lighting that till now it has not become a matter at all prominently pressing itself upon your company?—It has not.

I believe your attention has been very much drawn to it very recently in consequence of actual works which have been carried out within the last few months by one electric lighting company?—Within the last few weeks.

That company being which company?—The Kensington and Knightsbridge Company.

In various cases of recent Acts, not for electric lighting but for railways and so on, which would have interfered more or less with your mains, you have sought protection and obtained the insertion of clauses which, *mutatis mutandis*, are substantially the same as those which are now submitted to the committee?—Yes.

The WITNESS continued, that in the past his company had obtained the insertion of substantially similar clauses to those now sought to be secured in the Electric Lighting Companies' orders. Those protective clauses first appeared in the Metropolitan Railway Act of 1876; and since they had been inserted in connection with several other railway companies. Those clauses had all been obtained without the company having to appear, as now, before a committee. The company was under statutory obligation to supply gas, when required, to all houses and buildings in the district at all hours of the day and night and to keep the gas maintained at a constant pressure. And there were pipes in the houses in connection with the company's mains. He had carefully considered the clauses of the provisional orders, and they were not sufficient to protect the gas companies against probable contingencies. They stopped at the protection which was absolutely necessary in the case of an enormous supply of gas, such as that of the Gas Light Company. There were two main things to be guarded against, viz., interruption of supply to the public, and accident by explosions and damage arising from leakage. So far as the first, he said that the company lighted with gas nearly all the Metropolitan railway signals and any interruption would cause the extinction of the lights there. They had had painful experience in the past of the accidents from leakage, but he would rather the engineer's evidence were given on that subject. They had been obliged recently to take legal proceedings for the protection of their pipes against the local authorities, especially in regard to steam rollers, which were considered of excessive weight, and which had broken the mains and caused explosions and some personal injury. They had in every instance obtained protection from the Court. In some parts of the district the nature of the soil was shifty, and in any disturbance of the soil there was a subsidence of the mains and consequent fraction. And a fracture meant immediate leakage of gas and it was impossible to say whence the leakage would lead to, for the action on the main was most extraordinary. As to the question of the provisional clauses and the model clauses 16 and 17, he said it was not possible to lay mains for electric current without coming into actual contact or close proximity to the gas mains.

Will you explain to the committee what has happened within the last few weeks in connection with the electric lighting company which you have spoken of?—The particulars will be described by the engineer and the inspector who is on the ground, but, speaking generally, the Kensington and Knightsbridge Company were carrying their works along Ennismore Gardens, South Kensington, where the houses are very large. We have a main running down the roadway which happened to be in the way of the electric supply company, who were desirous of constructing a culvert for carrying their wires. They gave us no notice on the subject, but they constructed a culvert, I believe, something like 18 inches square on the inside, and our main pipe, which was in the way, was undermined, the earth taken away from it, and the main pipe was enclosed diagonally in this culvert. Traffic passing over this culvert would, of course, jar the main pipe, which had two joints upon it, and those joints would naturally become loosened by the jarring, and an escape would, no doubt, have taken place. The escape would have taken place inside the culvert, and as they had openings in their culvert to admit of the passage of their wires, the gas would have escaped from the culvert, and possibly have got into one of these big houses and fired, and a bad accident might have been the result.

Clause 16 entirely ignores the fact that besides the pipes you have under the streets syphons and other subsidiary works?—Yes, we have large syphons and great valves and various appliances indispensable to the distribution of the gas and the maintenance of its pressure.

(To be continued.)

SOME RECENT ELECTRICAL WORK ON THE ELEVATED ROADS AND ITS BEARING ON THE RAPID TRANSIT PROBLEM.*

By LEO DAFT.

IT is particularly noticeable that all who have so far considered the question of rapid transit for the City of New York, have assumed that it so deficient in these facilities that the question was one of the most vital importance; and while I do not for a moment wish to underestimate the urgency of the demand to meet the rapid growth which has already almost overtaxed the elevated system, we should not lose sight of the fact that New York has even to-day, all things considered, a better rapid transit system than any other city in the world. In evidence of this it is only necessary to cite the fact that one may enter a well appointed car at the Battery, and, travelling through the best atmosphere of the city, be carried with remarkable smoothness to Fifty-ninth Street in 26 minutes, or at the average speed of 12 miles per hour, including stops, and in about this manner the elevated system contrives to carry one-half million passengers per diem for a lower rate of fare than is done in any other city for similar accommodation, and with a smaller proportion of accidents than may be found on any steam road in the world, making an equal number of stops per 100 miles run. On a recent holiday, namely, April 30th last, 835,721 passengers were carried on this much abused system without noticeable detention or accident; but New York wants more, and, in view of the rapidly growing traffic which has already almost exceeded the ability of the system, it must be admitted that the demand is a pressing one, as this one half-million will grow to one million in a short time, and it is exceedingly improbable that any steam motor can be devised to permit of this increase, at least on the present structures, without subjecting them to quickly destructive strains. With steam, therefore, the only avenue open for increasing the passenger capacity, namely, the use of longer trains, is obviously out of the question, since it is a notorious fact that the present motors are taxed to their utmost.

To the mind of the mechanical engineer, having in view the ordinary coefficients of tractive ability, there is no remedy for this, but I think I shall be able to produce at least some little evidence that, owing to certain effects which have not yet been satisfactorily explained, an electric motor may be made capable of solving the problem at least so far as the ultimate strength of the present elevated structure will permit, inasmuch as the effects alluded to certainly do increase the tractive ability beyond that obtained by the use of any coefficients which may be found in the works of that eminent authority, D. K. Clark, or still later in the excellent treatise on the "Economic Theory of Railroad Location," by A. M. Wellington.

That these coefficients are not absolutely trustworthy is evident not only in the hesitancy with which they are treated by these authors, but also from the fact that varying coefficients are to be found in use by practical men, where the conditions do not differ in any appreciable degree. This is noticeable to the extent of nearly 20 per cent., *vide* D. K. Clark and A. M. Wellington. I will not, therefore, make pretence to great precision on this point, as the matter is one yet under investigation; but to quote an extreme case, I trust I may be pardoned for going back so far as the year 1882, to the first series of experiments in which this increased tractive capacity was observed and carried to its apparent maximum.

During a series of experiments with small motors, made at the works of the Daft Company at Greenville, N. J., in the year above quoted, I constructed an adjustable incline upon which a small motor was caused to ascend with a gradually increasing gradient until the extraordinary angle of 2,900 feet per mile, or 54·9 per cent., was reached. Up to this point the motor, weighing 450 lbs., plus one man weighing 150 lbs., total 600 lbs., was readily started from a position of absolute rest at the bottom, and ascended the gradient, being occasionally stopped midway, and started again with perfect ease. When this final gradient was reached, however, the ascension was less easy and certain though it was accomplished several times, but an attempt to exceed it resulting in failure; this was regarded as the maximum under those circumstances.

Now, let us for a moment consider what this actually indicated: A motor having a total weight of 600 lbs. will have a rolling resistance certainly equal to 10 lbs. per ton, making 2·25 lbs. for this item; at 54·9 per cent. the grade resistance will be 320·4, making a total of 331·65 lbs., or 55·27 per cent. of the total weight, considerably more than double the ultimate working limit of adhesion under the most favourable condition cited by Wellington in the work already quoted; but as those conditions, namely, a perfectly dry rail with drivers absolutely free from any lubricant, are so rarely found in practice as to be scarcely worth taking into account in every-day work, it may fairly be considered as equal to three times the ultimate effort usually developed before slipping occurs.

A prominent engineer in dismissing the idea of increased traction due to the passage of a current between the adhesive surface falls into the error of assuming that the effect would be precisely

* Read before the American Institute of Electrical Engineers New York, June 25th, 1889.

the reverse of that which has been observed, and in support of his argument cites the case of the lessened friction between the metallic points and the cylinder of chalk noted in a well-known instrument. I need hardly, however, call the attention of this audience to the entire absence of any proper analogy between these two cases. That the motor should not have ascended this gradient I am well aware; indeed, out of the commonest respect for such authorities as Messrs. Clark and Wellington, it ought to have stopped at the bottom of the gradient. merely rotating its wheels; but I was confronted by the indisputable fact that it did go up, and did it every day with perfect regularity for a number of days before many gentlemen, among whom were mechanical engineers, who could not account for that state of things at all—and, frankly, neither could I; but as a cold fact, it outweighed all the arguments in the universe. In illustration of my own doubts on the subject, I may mention a little instance that occurred at that time. I had written to a mechanical engineer of my acquaintance, stating the facts, and received in reply such an astonishing array of diagrams and mathematical proofs that this could not be done, that I actually went out into the yard and had the motor perform the feat several times before I felt strong enough to write my friend in a half apologetic way acknowledging the soundness of his views, but being compelled to reiterate the statement that the thing was being done just as I stated.

But, seriously speaking, the significance of this test can scarcely be overestimated, showing as it undoubtedly did the possibilities of working under conditions which have been hitherto considered impracticable.

Now, I do not for a moment pretend to assert that either dynamic or static adhesion may be increased to this extent by a large locomotive under the conditions of ordinary practice, as I am fully aware from subsequent experiments that the observed effect in this instance was due to a very large current of low potential passing through the very small contact areas presented by wheels 1 foot in diameter impinging upon a light 16-pound rail. The only effect is, however, undoubtedly obtainable to the extent of at least 30 per cent. under the ordinary conditions of railroad practice, since I have observed it many times with a dynamometer by causing the current to pass from wheel to rail in one series of measurements and through a cable connected with the motor in another series, and in this way results as high as 35 per cent. increase have been many times noted. In addition to this it is more than probable that the tractive efficiency of electric locomotives is higher than that of ordinary steam locomotives for mechanical reasons; and, in this connection, I cannot do better than quote Prof. John E. Sweet, in a recent article in the *American Machinist*, since it is put in a direct, clear, and simple manner. But as Prof. Sweet declines to admit the increase to be due to electrical action, I quote him simply in evidence of one of the mechanical advantages of the electric motor:—

TRACTIVE EFFICIENCY OF ELECTRIC LOCOMOTIVES.

Reference has been made to the fact that the electric locomotive will draw a considerably heavier load than the steam locomotive of the same weight, and the suggestion is advanced that it is due to some electric condition of the rails and wheels, while I believe it has been clearly shown that certain things slide one upon the other much more freely when a current of electricity is passing from one to the other than when not. I do not know whether, in the case of the Ninth Avenue cars, electricity passes from the wheels to the track; but if it does, the result is quite the reverse from the action assumed in the case of the locomotive wheels, and it does not seem at all necessary to refer the matter to any electrical or magnetic theory, as the mechanical conditions alone are such as to explain the apparent inconsistency, and in this way: The power of the electric mothor is constant, and the steam intermittent. If the steam locomotive has but a single cylinder, and the power required to draw the train be 700 lbs., the force exerted by the piston would be zero when the crank was at the dead centre, and 1,100 lbs. at the maximum; so that while the electric motor doing the same work would exert only 700 lbs. toward slipping the wheels, the steam locomotive with one cylinder would at times exert a force of 1,100 lbs. This assumption does not take into account the varying steam pressure nor the angularity of the connecting rod, which, in certain positions, would make it more, nor the weight of the reciprocating parts and the inertia of the drivers, which would make it less, though, as slipping takes place in starting the train, the inertia would have but little influence.

It is true that the steam locomotives are not single cylindered, and at first sight it would seem that that makes a vast difference, and that with two cylinders the impulse is almost constant; but even assuming the steam pressure to be constant throughout the stroke, as was assumed with the single cylinder, the rotary effect of the two cylinders is not constant, and (unless I am badly mixed in my diagram) with a mean 1,400 lbs., or double the mean of the single cylinder, there will be a minimum of 1,100 lbs., and a maximum 1,571 lbs. This variation, together with the varying steam pressure on the piston, it would seem, is sufficient to account for the extra efficiency of the electric motor, if I am correct in my assumption that the limit in both cases is the slipping of the drivers.

I have dwelt longer on this branch of the subject than it might seem to warrant, for the reason that an eminent authority, in a paper read some three or four years ago, emphatically declined to admit this line of argument or the existence of this effect, and in strongly advocating a multiple motor system, declared that increased weight was the only possible means of increasing the tractive ability of the motors, and that to propose any other plan was simply to shut our eyes to plain mechanical and engineering truths. I am pleased to observe that in a later paper the truth of the effects which I discovered and strenuously insisted upon early in 1883 have been acknowledged by the same authority.

Referring to the plan of multiple motors where it was proposed to use one or two machines on each car, while there can be no question that the advantages are theoretically very marked in some directions, I think the multiplication of motive parts, necessarily much smaller and more liable to disarrangement than those on one machine of equivalent power, together with enormously increased first cost and cost of attendance and repairs, present practical disadvantages from which any railroad manager would naturally shrink; and, notwithstanding the able manner in which this plan has been presented and its obvious theoretical solution of a much vexed problem, I do not see any reason for changing my original plan; on the contrary, exhaustive experiments recently conducted lead me to the conclusion that the problem may be readily solved in another way.

Lest any misunderstanding should exist as to the object of this series of tests, permit me here to remind you that this motor was not expected to solve the problem by towing longer trains at higher speeds than are at present attained. It was simply for the purpose of proving that a machine weighing a little more than one-half the present motors would equal, or nearly equal, their performance in that respect, and while it must be admitted that in the matter of acceleration on the heavier gradients the steam motors still show somewhat greater ability, the result of the test indisputably proves that, with motors of the same weight as those now employed, at least six car trains on the Ninth Avenue, and seven to eight car trains on the Sixth Avenue, may be propelled at a considerably higher average speed than at present; and when the absence of reciprocating parts is taken into account, the advantage on the side of the electric motor, in lessening the destructive strain on the structure, will form an important factor in the economy of operation. That the absence of this destructive strain is no idle dream of the mechanical engineer has been fully realised by many competent observers of the electric trains, since it has been a subject of general remark that the noise of the electric train is merely that inseparable from the rolling of the wheels over the track, the motor itself making no more noise than one of the cars in tow.

I refer to these points particularly, because so many disappointments have been experienced by the public, who seem to expect the electrical genii to waive his magic wand over the earth and cause all mechanical difficulties heretofore experienced to vanish in a moment, hence it is pleasant to be able to refer to the actual accomplishment of some of the most desirable advances in municipal rapid transit.

But the principal object is to show without fear or favour that it is now possible to run and compete with steam on the Ninth Avenue railroad and, of course, any of the others with a certain concrete economy based upon a series of tests made under circumstances to the last degree prejudicial for an economical showing, and without taking into account the great gains which would inevitably result from the use of a large central station, with dynamos of the highest efficiency, and with the obvious advantage resulting from the operation of a number of motive units under varying loads from a central station or dwelling upon such abstract economies as freedom from cinders, dropping water, smoke and noise.

Before proceeding to a review of the actual accomplishment, allow me to briefly describe the motive machine in question: The motor, named "Ben Franklin," consists of a frame having two driving wheels coupled by discs outside of the bearings, with two cast-steel cut split gears mounted on the back axle, and an electric motor pivoted on pedestals at the rear of the cab, and supported on similar pedestals with a screw adjustment for raising the whole machine to remove the armature and wrought-steel pinions in nearly vertical engagement with the gears.

It is evident that a considerable degree of resilience is not permissible with such an arrangement, but a sufficient amount to prevent excessive hardness in working is obtained by placing alternating plates of rubber and iron in the pedestals above and below the bearings. A similar arrangement at the driver-bearings cushions the machine without interfering with the mesh to an appreciable degree. In fact, what little wear has so far been observed between pinions and gears shows remarkable uniformity of engagement.

Before the motor was placed in the cab, it was deemed advisable to make a few Prony brake tests of its ultimate ability; it was therefore placed in the central station at Fifteenth Street, and a series of tests made resulting in the development of 128 H.P. A few higher readings than this were apparently taken, but as some little doubt was felt as to the accuracy of the observations, those were rejected and the above accepted as the ultimate reading.

The piece of track upon which the experiments have been conducted is eminently adapted for testing the tractive ability of a motor for this purpose, since there is only one piece of level track, 2,200 feet in length, the rest, embracing a distance of 1·846 miles, consisting of gradients varying between 11·3 and 98·7 feet per mile, and, in one instance, namely at Thirtieth Street, the start is made only a few feet from the bottom of a 98·7 foot gradient, thus testing the tractive capacity of the motor to the utmost.

In October last, experiments with this machine were begun on

this piece of track, which through the courtesy of Col. Hain was placed at my disposal from 9 o'clock at night until 4 o'clock the next morning, and the first experiment consisted in taking a light load of one or two cars over the road to test the conductor and switch connections. This train was gradually increased night after night until one of eight Ninth Avenue cars, each weighing 12 tons, was towed over the entire road, going up the 98·7 foot grade at a speed of 7¼ miles per hour and making the entire distance in 7 minutes 35 seconds, or an average speed of 14·6 miles per hour. Although a drizzling rain prevailed and the rails were slippery, there was an entire absence of slipping.

I regret that at the time of this experiment we were not using the dynamometer, but taking the ordinary coefficient of rolling friction for a light train of this kind, namely, ·004, and assuming that the grade resistance to be at the same rate per cent. of the total weight of the train as the rate per cent. of the grade, and the rate per cent. of the grade being 1·86, we get the following:—

$$\frac{1{\cdot}86 \times 4{,}781 \times 660}{33{,}000} = 95{\cdot}8 \text{ H.P.},$$

to which should be added at least 15 per cent. for friction and a so-called "head resistance" of the motor, equaling 14·37 H.P., or a total of 110·17 H.P. at Fifteenth Street. The maximum velocity obtained by that train on the level in passing Twenty-third Street was 24 feet per second, or 16·36 miles per hour.

These tests were continued for several weeks at intervals of two or three nights, during which time a great number of experiments were tried as to the ability of the motor to make the switches, start on gradients, &c. And I am able to state as a simple matter of record that though the tests were of the most exacting character, absolutely the only repairs or delay during all this time, and subsequent tests were two, once when a spool had to be removed from developing a contact, which caused a delay of one night, and the other time when a moving axle wore a hole through the insulation of an end spool and caused a detention of 15 minutes. With these two exceptions the motor has been ready to run at any moment during the whole time in spite of the roughest treatment, and being left on the track exposed to the weather for months past.

I think I am entitled to say that these results, which were, of course, carefully watched by the Manhattan railway officials, led to our obtaining permission to run in the day time between steam trains—a permission which you may be sure would not have been granted on a road which has a world-wide reputation for its almost military discipline and precision of management, if the motor had not earned the right to some confidence. On January 28th, 1889, we began running between the hours of 11 and 2 in the day time, which was continued with a three-car and occasionally a four-car train, running express, until February 12th, when we requested to take a train of flat cars loaded with iron to the weight of an average four-car train with 75 to 100 passengers, in lieu of the light train formerly employed. With this train, weighing in all 70 tons, I made several trips over the road between the ordinary steam trains; but finding the brakes hardly trustworthy enough for such critical work, with trains only three minutes from us on either side, it was decided to discontinue this service, and a four-car Sixth Avenue train was substituted. With this train several trips were made, but in consequence of the absence of air brakes it was not considered advisable to proceed with the ordinary "stop run," and the remainder of the work was done at night; but I may say that during this period of 30 days, with one exception above noted, not the slightest detention was caused by the regular trains, as we were always able to switch on to the track, make our trip, and get back on to the switch at Fiftieth Street without interfering with the steam trains in the least.

A number of experiments made about this time show that the mean speed, with a three-car empty train, running express, on the up-town track, was about 23 miles per hour, though on the level the ability of the motor, with a similar train, is nearly 28 miles per hour. This is by no means the limit of speed which the motor is capable of attaining, for as will be seen by reference to diagram, fig. 1,* the work of acceleration was still in progress when the gradient at Twenty-fourth Street was encountered; hence it seems perfectly fair to assume that even with that 40-ton train, the maximum level is not shown. With a lighter load the speed would undoubtedly be much greater, but for prudential reasons it was not deemed well to push this matter of speed to its extreme limit, especially in view of the fact that the machine was not designed for a speed of over 25 miles per hour, and any derangement resulting from excessive peripheral armature speed might have prevented my ability to present a clean record to-night.

To any one travelling on a structure similar to the Ninth Avenue Elevated Road at a speed of 28 miles per hour, particularly at night, and at an altitude of 30 feet, seems to be sufficient for all practical purposes; and I must confess that in driving the motor at that speed under these conditions I was conscious of a marked absence of any desire to greatly increase it, neither does it seem to be necessary that greater speeds than 30 miles per hour should be attained in the city limits (by express trains) to meet all the proper requirements of rapid transit; and when the great power which experiment shows to be required for the accelerative effort between the frequent stations and with the comparatively heavy trains on the Sixth and Third Avenues are taken into account, it is extremely improbable if this speed will ever be exceeded between stations on these structures.

(To be continued.)

* This will appear in our next.—EDS. ELEC. REV.

NEW PATENTS—1889.

11315. "An electric motor arc lamp." A. W. RICHARDSON. Dated July 15.

11317. "A method of and apparatus for controlling steam and gas engines by means of electricity." H. WHITESIDE-COOK. Dated July 15.

11341. "Improvements in recording apparatus for electric meters." G. W. WALKER and W. BRACKEN. Dated July 15. (*Complete.*)

11419. "Improvements in electric meters." SIEMENS BROS. and Co., Limited. (Communicated by the firm of Siemens and Halske, Berlin.) Dated July 16.

11422. "Improvements in and relating to bulbs or globes for incandescent electric lamps." T. G. LITCHFIELD. Dated July 16.

11426. "Improvements in the mode of driving, by means of electric motors, tram car and other mechanism, and in apparatus for reducing in transmission the speed of rotation derived from electric and other motors." P. A. NEWTON. Communicated by W. Main, United States.) Dated July 16. (*Complete.*)

11429. "Improvements in the manufacture of electric lamps." P. M. JUSTICE. (Communicated by J. Clegg, United States.) Dated July 16.

11430. "Improvements in electrodes or filaments for electric lamps." P. M. JUSTICE. (Communicated by J. Clegg, United States.) Dated July 16.

11471. "Improvements in electric accumulators or storage batteries." E. N. REYNIER. Dated July 17.

11501. "Improvements in the construction of electric fuses and detonators, and in the method of and appliances employed for manufacturing the same." P. WARD and E. M. GREGORY. Dated July 18.

11519. "Improvements in roses for supporting electric lamps." C. W. FARQUHAR and H. L. DOULTON. Dated July 18.

11528. "Improvements in electrode plates for electric accumulators." C. BEYER and G. HAGEN. Dated July 19.

11574. "Improvements in and connected with insulators, electrical conductors, and conduits for same, partly applicable for telpherage and other electric lines." W. J. L. HAMILTON. Dated July 19.

11581. "Improvements in electrical alarms." N. G. THOMPSON. Dated July 20.

11615. "Improvements in conduits and rails for electrical and other railways." F. H. REED and G. N. MCKIBBIN. Dated July 20.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

434. "Dry galvanic cells." C. H. MEHNER. Dated January 9. 4d. Claim:—In a dry galvanic cell the employment of basic chloride of magnesium formed with an excess of neutral salt with water of crystallisation for the purpose of converting the exciting liquid into a nonflowing pasty or gelatinous mass, substantially as described.

1223. "Reply telegraphs for engine rooms and other purposes." E. BERG. Dated January 23. 8d. Relates to a system of telegraphs which enables the commander to be in immediate communication with his engineer at the signal receiving station, for the purpose of receiving the reply of that order communicated to the engineer by the commander, in a manner either executed by the engineer himself directly or indirectly, or automatically by the engine or machine in charge of the engineer. 3 claims.

1343. "Improvements in instruments for measuring electricity." F. H. NALDER, H. NALDER, C. W. S. CRAWLEY and A. SOAMES. Dated January 24. 6d. Has reference to instruments for measuring electricity known as ammeters and voltmeters. It consists in so arranging the piece generally called the cock-piece that carries the pivot of the moving system, that the pivot shall be in a vertical line passing through the centre of the dial and that the instrument shall present a perfectly symmetrical appearance, notwithstanding that the pivot is eccentric with regard to the coil or solenoid. The invention further consists in forming the needle of one or more pieces of soft iron wire set in a brass holding piece and secured therein by pinching this piece. A very soft iron needle can easily be produced in this form; if the needle is united to a holding piece by soldering, the heat tends to harden the iron. The invention comprises the attachment of the bobbin to the face of the instrument only, and for this purpose it may either be secured thereto by screws or be made in one piece therewith. 4 claims.

1401. "An improved mode of generating electricity by dynamo-electric machines." I. T. DYER, P. FISH, and R. C. FISH. Dated January 25. 6d. The invention consists in a dynamo-electric machine having two sets of magnets and movable armatures, one within the other; and it further consists in details of construction and combinations of parts. 5 claims.

1611. "Improvements relating to multiplex electric telegraphy." M. W. DEWEY. Dated January 29. 8d. Consists in

so combining several sections of battery with three single-current transmitters or keys and one double current or pole-changing transmitter or key that when a certain key or keys are operated they will send currents to line that will select and operate the corresponding receiving instrument or instruments and no other. It also consists of the combination of seven neutral relays whereby three sounders or registers may be properly operated by the three single-current transmitters, and one polarised relay which operates independently another sounder or register whenever the current is reversed by the double-current transmitter. 13 claims.

1677. "An electric switch." G. H. WHITTINGHAM. Dated January 30. 8d. Has relation to an electric switch designed for use in starting and stopping the supply of an electrical current to a conductor or conductors employed in transmitting the same for lighting or other mechanical purposes, the object of the invention being primarily to so control the delivery of the electrical current to the motor or to the conductors that the supply shall be gradual, in order that the motor or the mechanism to which the conductors lead shall be prevented from any injurious effects arising from an overcharge of the current. 10 claims.

1892. "Improvements in electric motors and means for regulating the same. A. J. BOULT. (A communication from L. W. Serrell and H. L. Lufkin, both of New York.) Dated February 2. 8d. Has for its object to provide an electric motor which is adapted to be used in constant current circuits, and which will be self-regulating and run at practically a constant speed under all variations of load or work to be performed, and which shall be saving of potential under all stages of the development of its powers, and practically uniform in efficiency; and the invention consists in the general arrangement of circuits and devices whereby these ends are attained. 3 claims.

2066. "Improvements in the manufacture of electrodes for secondary batteries or accumulators." L. PAGET. Dated February 5. 6d. Relates particularly to the process of preparing electrodes for use in secondary or storage batteries, and to the electrode when constructed in conformity with such process, and its object is to devise a simple, more expeditious, and cheaper method of constructing the electrodes of that type of secondary or storage batteries, in which the active material, or material adapted to become active, is sustained or supported by grids, frames, or analogous retaining devices. 9 claims.

2276. "Improvements in the construction and arrangement of primary batteries." E. GUITTON. (Communicated from abroad by M. Sappey, of Paris.) Dated February 8. 11d. Relates to a generator with perfectly automatic feed or renewal. 4 claims.

2406. "Improvements in the mechanism of electric arc lamps." J. ROPER. Dated February 11. 6d. Principally relates to an arrangement whereby the armature of the main coil, when attracted to the cores and in its normal or working position, lifts a worm into gear with the teeth surrounding the periphery of the pulley from which the upper carbon is suspended. The worm, when in gear with the teeth of this pulley, is actuated intermittingly by means of a vibrating spring suspended at the end of the shunt coil, which spring is connected to a ribbon or strap passing round a drum which actuates the arbor upon which the worm is mounted. This motion of the worm slowly rotates the pulley with which it engages, and thereby lowers the upper carbon holder, which is suspended by means of a chain from the pulley. 4 claims.

2952. "Improved electric relay apparatus for submarine telegraphy and other purposes." H. H. LAKE. (Communicated from abroad by C. E. Dressler, of New York.) Dated February 19. 11d. Relates to the art of transmitting electro-magnetic impulses for telegraphic and other purposes, notably for long distances, as in the case of ocean telegraphy through submarine cables. 14 claims.

3350. "An improved instrument for measuring currents of electricity." Sir C. S. FORBES. Dated February 25. 8d. The object of the invention is to so utilise the thermal or heating effect of the direct or alternate current passing through a measuring instrument as to obtain a step by step motion suitable for driving a hand or pointer over a dial, or a train of wheels or equivalent device for indicating the value in current or energy taken by the user. 5 claims.

3881. "Improvements in the method of and apparatus for regulating electric currents." J. W. BALET. Dated March 5. 1s. 3d. The object of the invention is chiefly to provide a current regulator for dynamos and motors by which the current not used, and any surplus of current, will be sent into accumulators to be stored for future use when the main current from the dynamo becomes weakened, or ceases altogether, and to control the charging of the secondary batteries, so that the charging current shall cease in a particular battery when the maximum charge is reached and be returned to the said battery when it is discharged. 34 claims.

4722. "Improvements in coupling devices for electric conductors." H. H. LAKE. (Communicated from abroad by A. Clark Griggs, of America.) Dated March 18. 8d. Relates to couplings for two electric wires forming or adapted to form part of an electric circuit, and it is especially designed for use in a system of electric signalling from the cars of a railway train to the engine, such, for instance, as is shown and described in the inventor's American patent, No. 393,431, of November 27th, 1888. 5 claims.

4800. "Improvements in electric conductors." H. H. LAKE. (Communicated from abroad by A. A. Brooks, of America.) Dated March 19. 6d. Relates to a jacketted electric conductor, the jacket of which is made of filling threads which are parallel with the conductor, and two or more uniting threads which are woven in and out among the filling threads, and caused to be wound about the conductor. 4 claims.

4960. "Improved means for administering electricity to and otherwise treating horses and other animals." GEORGINA MCGUIRE LAWRENCE. Dated March 21. 8d. An important feature of the invention is the provision of novel means for elevating or raising horses or other animals from the ground, and whereby the difficulties or inconveniences attending the slinging of such animals, as hitherto usually practised, are obviated or greatly diminished. 9 claims.

5142. "Improvements in systems of electrical distribution." S. C. C. CURRIE. Dated March 26. 8d. Has relation to systems of electrical distribution, and relates more particularly to that class of distributive systems wherein a number of accumulators or secondary batteries are employed as distributing centres for independent districts, and wherein the accumulators are arranged for charging in series upon a single main conductor conveying the charging current from a distant source of electrical supply. 9 claims.

5293. "Improvements relating to apparatus for the distribution and conversion of electric currents." T. H. HICKS. Dated March 27. 6d. Relates to a system of electrical distribution and conversion whereby alternating, pulsating, or intermittent currents of electricity of high tension are converted into low tension currents, suitable for electric lights or electric motors, and the invention consists in the peculiar arrangement of an inductorium, and its combination with a main or translating circuit. 1 claim.

5612. "Improvements relating to the distribution of electric currents and to apparatus therefor." H. H. LAKE. (Communicated from abroad by E. Wilbur Rice, jun, of America.) Dated April 2. 8d. Claims: 1. The described system of electrical distribution, comprising alternating current mains leading from a point of alternating current supply one or more converters or transformers of the ordinary description connected to said mains, leading wires or mains connected with the secondaries of said converters, and one or more induction transfer coils connected across said leading wires, and having connected with them three or more sub-circuits or distributing wires, each two sub-circuits having a fraction of the transfer coil included between them, as and for the purpose described. 2. The described system of alternating current distribution, comprising alternating current mains leading from a suitable source of current supply, converters or transformers connected in multiple across said main, leading wires or mains connected to the secondaries of said converters, induction transfer coils connected across said leading wires, and sub-circuits or distributing wires leading from and including a fraction of said transfer coils, said leading wires supplying current to still other transfer coils for the purpose of still further sub-dividing the potential, as and for the purpose described.

5621. "Improvements in and relating to electric induction coils or transformers." H. H. LAKE. (Communicated from abroad by Elihu Thomson, of America.) Dated April 2. 8d. The object of the invention is to regulate or adjust the current made to flow in the second of two coils by the alternating currents in the first. The invention is especially applicable to that class of apparatus known as induction coils or transformers, and can be used for obtaining a current from the secondary, which differs radically in properties or character from that from which the primary draws its supply. 4 claims.

5912. (Under International Convention.) "Improvements in systems of suspending electric conductors." C. J. VAN DEPOELE. Dated April 6. 8d. Relates to improvements in means for supporting the suspended supply conductors used in what are called the overhead supply systems of electric railways, to an improved arrangement and construction of said supporting devices, and to various other details of construction, such as insulators. 19 claims.

5913. (Under International Convention.) "Improvements in devices for establishing electrical contact in electric railways." C. J. VAN DEPOELE. Dated April 6. 8d. Relates chiefly to a duplex form of contact device for maintaining contact with both conductors, when both positive and negative line conductors are suspended above the track, in contradistinction to the system employing but a single overhead conductor for each track, the track rails themselves being utilised as the return circuit. 9 claims.

6119. "Improvements in thermo-electric batteries." J. J. SHEDLOCK and R. MESTERN. Dated April 9. 8d. Consists in constructing the thermo-electric elements in such a manner that they are able to resist for long periods the action of the high heats to which they are subjected, without deterioration and reduction of their power as generators of electricity; and also the method of combining and arranging such elements with a furnace and combustion tube, in which solid, liquid, or gaseous fuel may be consumed for its direct conversion into power and light. 5 claims.

6423. "Improvements in electrical motors and apparatus connected therewith, especially applicable to purposes of locomotion." A. J. JARMAN. Dated April 15. 8d. Relates to the construction and application of electric motors to tramway and railway locomotion, and is based upon the subject of the invention described in specification, No. 2,783, of A.D. 1886. 8 claims.